Volume 22, Number 21, November 15, 1968

# NUCLEAR SCIENCE ABSTRACTS

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### Index References

All index entries refer the reader to volume and abstract number:

```
FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
```

### Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

```
MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

### Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

```
SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hemstopoietic system of, x,
    21:8905(R) (AD-631189)
```

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SHELTERS
  construction of, for civil defense,  21:8838
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    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8860 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
```

### Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

**8500** (Y-1561) MIXING AND SAMPLING ENRICHED $^{235}U$ FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

```
UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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TID-
  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23287        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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# NUCLEAR SCIENCE ABSTRACTS

## CHEMISTRY

### Analytical Chemistry

*Refer also to abstracts 45029, 45153, 45280, 45318, 45629, 46236, 46699, and 47040.*

**44970** (AERE-A/M-103) ANALYTICAL PROCEDURES USED BY THE BIOASSAY SECTION AT A.E.R.E., HARWELL. Eakins, J. D.; Lally, A. E.; Morgan, A.; Sandalls, F. J. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1968. 61p. Dep. CFSTI. UK 9s.

Procedures for the determination of radionuclides in urine, used at A.E.R.E., Harwell, were compiled in 1960 by Brooks (U.K.A.E.A. Unclassified Report AERE-AM 60). Since that time most of the procedures have been replaced by others which are either more sensitive or simpler in execution. Details of these improved methods are described. They have all been in use for some time and no special skills are required to achieve satisfactory recoveries. (auth)

**44971** (AERE-R-5763) GRAPHITE RESISTANCE FURNACE FOR USE IN THE INERT GAS FUSION METHOD OF DETERMINING GASES IN SOLIDS. Taylor, B. L. (Atomic Energy Research Establishment, Harwell (England)). May 1968. 8p. Dep. CFSTI. UK 1s. 9d.

A high-current-resistance furnace was designed for use in the inert gas fusion method of determining oxygen and nitrogen in materials. The heating element and heat shields are graphite. Particular attention was given to those features that are important when the furnace is used in controlled-atmosphere glove boxes. (auth) (UK)

**44972** (BNWL-SA-2010) MULTIELEMENT ANALYSIS OF BIOLOGICAL MATERIAL BY NEUTRON ACTIVATION AND DIRECT INSTRUMENTAL TECHNIQUES. Rancitelli, Louis A.; Cooper, John A.; Perkins, Richard W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 2, 1968. Contract AT(45-1)-1830. 13p. (CONF-681003-5). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

Comparative methods of neutron activation analysis were developed and applied, which permit the direct instrumental measurement of some 20 trace elements in biological materials. The method involves a minimum of preirradiation handling, requiring only that the sample be freeze dried prior to neutron irradiation. (M.C.G.)

**44973** (JINR-P7-3855) EXPERIMENTS ON THE CHEMISTRY OF THE ELEMENT 104-KURCHATOVIUM. IV. CHEMICAL AND RADIOMETRIC METHODS OF ANALYSIS. Caletka, R.; Shalaevskii, M. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 23p. (In Russian). Dep.

The methods of radiometric analysis, used in experiments on the development of a fast and continuous method for separation of short-lived products of nuclear reactions, are described. Desorption of the activity from the equipment (which was used to compare the volatility of the element 104 chlorides with those of hafnium, rare earth, and transplutonium elements) and the chemical separation and radiometric identification of plutonium isotopes, transplutonium elements, $^{168,170,171}$Hf, $^{44,44m}$Sc, and $^{24}$Na, are presented. (auth)

**44974** (KFK-747) X-RAY FLUORESCENCE ANALYSIS OF URANIUM AND PLUTONIUM IN NUCLEAR FUEL SOLUTIONS. Ertel, Dieter; Wettstein, Werner (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heiss- Chemie). Mar. 1968. 27p. (In German). (EUR-3728). Dep.

By intensity measurements of the $L_{\alpha_1}$ line, uranium and plutonium can be determined in aqueous and organic solutions in the presence of one another with thorium serving as the internal standard. The analysis region ranges from 0.003 to 10 mg U,Pu/ml. The sensitivity of the method is $10^5$ impulses/mg U,Pu/ml. For extreme U/Pu concentration ratios and in the presence of large amounts of impurities, background measurements on each sample are necessary. For rapid determination of uranium and plutonium in pure fuel solutions a routine method was developed. In the optimum measuring region the standard deviation is about ±1%. The time requirement for a single determination is about 15 min and for series analyses about 5 to 10 min. (tr-auth)

**44975** (MIT-905-125) EXTENSIONS OF THE USE OF Ge(Li) DETECTORS IN INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF GEOLOGICAL SAMPLES. Gordon, G. E.; Baedecker, P. A.; Anderson, C. F. L.; Dran, J.-C. (Massachusetts Inst. of Tech., Cambridge). Aug. 28, 1968. Contract AT(30-1)-905. 9p. (CONF-681003-4). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

The use of Ge(Li) detectors in instrumental neutron activation analysis was extended to very short-lived species and to classes of geological samples not previously studied. Concentrations of Al, Mg, and V were determined in ultramafic rocks and stony meteorites. (M.C.G.)

**44976** (MLM-1543) DIRECT DETERMINATION OF IRON AND URANIUM BY CONTROLLED-POTENTIAL COULOMETRY. Bohl, D. R.; Sellers, D. E. (Mound Lab., Miamisburg, Ohio). Sept. 5, 1968. Contract AT(33-1)-Gen-53. 8p. Dep. CFSTI.

A method was developed for the direct determination of iron and uranium in mixtures by controlled-potential coulometry. A solid-state controlled-potential coulometer designed and built at Mound Laboratory was utilized. The coulometric titrations were performed using a mercury cathode as the working electrode. The iron and uranium were titrated by controlling the potential of the mercury cathode at −0.04 and −0.35 V, respectively, versus the saturated calomel reference electrode. The iron and uranium contents of the sample were calculated using the integrated electrolysis currents and Faraday's law. Aliquots of a saturated iron–uranium mixture, containing 1.92 mg of iron and 1.21 mg of uranium, were titrated using the recommended method. The accuracy and relative average deviation of the iron determination were −0.09 and ±0.11%, respectively. The accuracy and relative average deviation of the uranium determination were +0.08 and ±0.30%, respectively. (auth)

**44977** (NBS-TN-406) X-RAY WAVELENGTH CONVERSION TABLES AND GRAPHS FOR QUALITATIVE ELECTRON PROBE MICROANALYSIS. Heinrich, Kurt F. J.; Giles, Mary Ann M. (National Bureau of Standards, Washington, D. C.). Sept. 25, 1967. 58p. GPO $0.70.

Tables and graphs have been constructed for electron probe x-ray spectrometers equipped with crystal changers and calibrated for LiF crystals in angstroms. These tables indicate the equivalent reading for the lines which can be normally expected to appear in wavelength scans using the following crystals: LiF, EDDT, ADP, KAP, and Pb stearate (LSD). The readings were extracted from the tables of E. W. White, et al. The tables are

arranged by the atomic numbers of the emitting elements; the graphs show the readings for observable lines as a function of atomic number for each of the aforementioned crystals. A suggested method for using the tables and graphs is included. (auth)

**44978** (NP-17585) RADIOCHEMICAL METHODS OF ENZYME ASSAY. R.C.C. Review 9. Oldham, K. G. (Radiochemical Centre, Amersham (England)). Mar. 1968. 49p.

The present uses and potential of radiochemical methods of enzyme assay are examined and a bibliography is included. Various techniques are discussed and possible sources of errors in the assay and in the interpretation of results are considered. Examples are considered from each class of enzyme. Factors important in radiochemical assays of enzymatic activity are reviewed. (180 references). (M.C.G.)

**44979** (NYO-2174-70) ACTIVATION ANALYSIS OF LANTHANIDE ELEMENTS IN MODERN CORALS: GERMANIUM DETECTOR PROCEDURES. Livingston, Hugh D.; Bowen, Vaughan T. (Woods Hole Oceanographic Institution, Mass.). Apr. 1968. Contract AT(30-1)-2174. 18p. (CONF-680446-1). Dep. CFSTI.

From Symposium on Rare Earths, Washington, D. C.

Lanthanide analysis, by neutron activation, on a series of modern stony corals, none of them reef formers, is described. Samples of dry, powdered coral were irradiated at a flux of $3 \times 10^{13}$ $n \cdot cm^{-2} \cdot sec^{-1}$ for 4.25 days. The data were obtained using a 4 $cm^3$, planar, Ge(Li) detector and a 512-channel analyzer. Results are presented in tables. The total lanthanide content of corals appeared to be markedly higher in specimens growing far from shore, and still higher in specimens growing in deeper water. The relative abundance pattern showed enrichment of the lighter lanthanides, except for cerium. (M.C.G.)

**44980** (NYO-3756-2, Sect. G) ENVIRONMENTAL STUDIES USING HIGH RESOLUTION GAMMA SPECTROSCOPY. Russell, Irving J. 10p.

Analysis of complex gamma-emitting systems using high-resolution spectroscopy is discussed. The power of the detector for environmental analysis was demonstrated. Measurements of U, K, and Th in rock samples are considered. Distributions of $^{137}Cs$ and $^{54}Mn$ in an oak tree were measured. A sample of fallout from the nuclear explosion of December 24, 1967 was analyzed. (M.C.G.)

**44981** (ORO-2670-28) THE NONDESTRUCTIVE DETERMINATION OF IRIDIUM IN METEORITES USING GAMMA-GAMMA COINCIDENCE SPECTROMETRY. Ehmann, W. D.; McKown, D. M. (Kentucky Univ., Lexington. Dept. of Chemistry). Aug. 30, 1968. Contract AT(40-1)-2670. 15p. (CONF-681003-6). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

A nondestructive procedure for the determination of Ir in meteorites containing at least 0.1 ppM Ir was developed utilizing neutron activation followed by gamma-gamma coincidence spectrometry. (M.C.G.)

**44982** (RFP-Trans-49) INVESTIGATION OF THE ACTINIDES. I. DETERMINATION OF THE $^{241}Am$ CONTENT IN PLUTONIUM BY MEANS OF $\alpha$- AND $\gamma$-RAY SPECTROSCOPY. Maly, J.; Kurzweilova, H.; Lenk, R.; Peka, I. Translated by Dennis G. Vasilik (Rocky Flats Div., Dow Chemical Co., Golden, Colo.), from Collect Czech. Chem. Commun., 25: 1383-91(1960). 22p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 14: 16622.

**44983** SPECTROPHOTOMETRIC DETERMINATION OF YTTRIUM WITH MOLYBDOPHOSPHORIC ACID. Madison, Bryan L.; Guyon, John C. (Univ. of Missouri, Columbia). Anal. Chim. Acta, 42: 415-21(Sept. 1968).

A simple sensitive spectrophotometric determination of yttrium, based on the reaction of molybdophosphoric acid with yttrium at pH 4.8, is described. The resulting complex is reduced and the absorbance measured at 695 nm. The method is applicable in the presence of several-fold excesses of lanthanum, cerium, and phosphate. (auth)

**44984** COMPARISON OF METHODS FOR THE ANALYSIS OF TIN-SAMARIUM ALLOYS. Percheron, A. (CNRS, Bellevue, France); Pinta, M. Anal. Chim. Acta, 42: 489-502(Sept. 1968). (In French).

Several methods of analysis for tin-samarium alloys are studied: chemical analysis, x-ray fluorescence and arc spectrography. Their characteristics and the results obtained are compared. The chemical methods are most precise but are insensitive and tedious. X-ray fluorescence is suitable for routine work and for control of alloy homogeneity. Arc spectrography is by far the most sensitive method. The methods can be applied to alloys of other rare earths with tin. (auth)

**44985** SIMULTANEOUS DETERMINATION OF TANTALUM AND HAFNIUM IN SILICATES BY NEUTRON ACTIVATION ANALYSIS. Greenland, L. Paul (U. S. Geological Survey, Washington, D. C.). Anal. Chim. Acta, 42: 365-70(Sept. 1968).

A neutron activation procedure suitable for the routine determination of tantalum and hafnium in silicates is described. The irradiated sample is fused with sodium peroxide and leached, and the insoluble hydroxides are dissolved in dilute hydrofluoric acid-hydrochloric acid. After $LaF_3$ and AgCl scavengers, tantalum and hafnium are separated by anion exchange. Tantalum is obtained radiochemically pure; $^{233}Pa$ and $^{95}Zr$ contaminants in the hafnium fraction are resolved by $\gamma$-ray spectrometry. The chemical yield of the procedure is determined after counting by re-irradiation. Values for the 8 U. S. Geological Survey standard rocks are reported. (auth)

**44986** RAPID DETERMINATION OF DYSPROSIUM IN ROCK SAMPLES BY NEUTRON ACTIVATION ANALYSIS WITH A Ge(Li) DETECTOR AFTER CHEMICAL SEPARATION. Tomura, Kenji (Rikkyo Univ., Yokosuka, Japan); Higuchi, Hideo; Onuma, Naoki; Hamaguchi, Hiroshi. Anal. Chim. Acta, 42: 389-95(Sept. 1968).

A neutron activation method for the rapid determination of dysprosium in rocks, based on simple chemical separation and $\gamma$-spectrometry with a lithium-drifted germanium detector, is described. The 94.7-keV photopeak of $^{165}Dy$ (2.3 h half-life) was measured. Several geochemical standard rocks covering a variety of rock types were analyzed. The detection limit was 0.005 $\mu g$ of dysprosium. A precision of $\pm 4.7\%$ was obtained on 7 separate analyses of a basalt standard rock. The accuracy of the method is discussed. (auth)

**44987** CATHODE-RAY-EXCITED EMISSION SPECTROSCOPIC ANALYSIS FOR TRACE RARE EARTHS. PART II. DETERMINATION OF EUROPIUM. Larach, Simon (RCA Labs., Princeton, N. J.). Anal. Chim. Acta, 42: 407-13(Sept. 1968).

Trace amounts of europium can be determined quantitatively in situ by excitation with cathode rays (electrons) and detection of europium transitions. Europium can then be determined from a standard plot of intensity vs. concentration. Matrix effects, voltage effects, detection lines, and rare-earth and first-transition-group interferences are discussed. While the detection limit of europium under normal conditions is about 0.1 ppM, optimizing the above effects yields an ultimate detection limit, by extrapolation, of about 0.005 ppM. (auth)

**44988** DETERMINATION OF IMPURITIES IN ZINC BY NEUTRON ACTIVATION. PART I. THE DETERMINATION OF SILVER AND COBALT IN ZONE-REFINED ZINC. Machiroux, R.; Mousty, F. (Univ., Liege). Anal. Chim. Acta, 42: 371-8 (Sept. 1968). (In French).

A neutron activation method for the determination of cobalt and silver in the microgram range in a matrix of electrolytic zone-refined zinc is described. Silver and cobalt can be separated in a state of high radiochemical purity by means of an anion-exchange resin, silver being eluted by 10 M hydrochloric acid and cobalt by 4 M hydrochloric acid. The standard deviations are, respectively, 0.1 ppM for silver and 0.01 ppM for cobalt for impurity levels of 1 ppM silver and 0.1 ppM cobalt. (auth)

**44989** COMPLICATING ROLE OF REACTIONS INDUCED BY ISOMERIC TRANSITIONS IN NEUTRON ACTIVATION ANALYSIS FOR $^{82}Br$ AND $^{130}I$. Lambrecht, R. M.; Rack, E. P. (Univ. of Nebraska, Lincoln). Analyst, 93: 550-1(Aug. 1968).

In neutron activation analysis for $^{82}Br$ and $^{130}I$, which have isomeric states, it is important to take into account possible isomeric transition induced reactions in the sample (and possibly also the sample container), and with solvent and solute if wet chemical procedures are carried out for the removal of interferences. In the simultaneous determination of iodine and bromine in urine by neutron activation analysis if the $^{82}Br$ separation is begun immediately after removal of the sample from the reactor considerable $^{82}Br$ activity may be discarded before the assay because of isomeric transition reactions of $^{82}Br$ with the $CCl_4$ used in solvent extractions. Evidence was obtained indicating that at least 50% of the activity resulting from $^{82m}Br$ to $^{82}Br$ isomeric transition reactions at dilute bromine concentrations will react with $CCl_4$. By waiting, however, until the short lived metastable isotope has decayed, before performing any chemical operations with the sample, complicating isomeric transition induced reactions are eliminated. With long lived metastable isomers, e.g., $^{80m}Br$, contributions from isomeric transition reactions are minimised by performing operations in a time interval short compared with the half-life of the metastable species being analysed. The neutron activation analysis of fallout $^{129}I$ is also discussed. (UK)

**44990** STUDY OF OSMIUM AND RUTHENIUM DISTILLATION WITH RADIOACTIVE TRACERS. Chung, K. S.; Beamish, F. E. (Univ. of Toronto). Talanta, 15: 823-9(Aug. 1968).

The distillation characteristics of osmium and ruthenium, which were studied by using both radioactive tracers and inactive compounds, are reported. The tracer solutions were prepared from hexachloro- and hexabromo-compounds and from the purified sponges of both metals. A quantitative separation of osmium from ruthenium can be made by distillation from peroxide–sulfuric acid solution at 110° for about 40 min. Slow and incomplete distillations were observed when osmium was present as either the chloro- or bromo-complex. Optimum conditions for the dissolution of acid-insoluble materials containing osmium and ruthenium are discussed. (auth) (UK)

**44991** DETERMINATION OF RARE EARTH CERIUM SUBGROUP ELEMENTS IN THE AIR. Deyanova, E. V. (Inst. of Sanitation and Occupational Diseases, Moscow). Gig. Sanit., No. 1, 78-81(Jan. 1968). (In Russian).

Colorimetric determination of cerium subgroup rare earths was achieved with a sensitivity of 0.5 μg in a certain volume. Separation of rare earth by precipitation as hydroxides with iron followed by iron separation on AB-16 resin is described. Microgram quantities of iron and aluminum may be masked by ascorbic and sulfosalicylic acids. (tr-auth)

**44992** IMPROVEMENTS IN PREPARATION AND OPERATION OF ELECTRODELESS DISCHARGE LAMPS AS HIGH INTENSITY SOURCES IN ATOMIC FLUORESCENCE FLAME SPECTROMETRY. Zacha, K. E.; Bratzel, M. P. Jr.; Winefordner, J. D.; Mansfield, J. M. Jr. (Univ. of Florida, Gainesville). Anal. Chem., 40: 1733-6(Sept. 1968).

An "A" antenna and a tapered rectangular cavity were used to couple microwave energy to the electrodeless discharge lamps. Various devices were used to insulate the lamps. Experimental operating conditions and limits of detection for several elements using atomic fluorescence flame spectrometry are tabulated. Limits of detection of many elements compare favorably with those of atomic absorption and atomic emission flame spectrometry. Data on Be, Ca, Cr, Fe, Ge, Hf, Mo, Ni, Sb, Sc, Sr, Ti, U, and Zr are reported for the first time. (J. G. B.)

**44993** DETERMINATION OF MOLYBDENUM BY CONTROLLED-POTENTIAL COULOMETRY. APPLICATION TO THE ANALYSIS OF MOLYBDENUM–TUNGSTEN–RHENIUM ALLOYS. Rigdon, L. P.; Harrar, J. E. (Univ. of California, Livermore). Anal. Chem., 40: 1641-5(Sept. 1968).

A procedure was developed for the determination of molybdenum by controlled-potential coulometry. The method is based on the reduction of Mo(VI) to Mo(V) at −0.25 V vs. SCE in a supporting electrolyte of 0.2M $(NH_4)_2C_2O_4$ and 1.3M $H_2SO_4$ at pH 2.1. Solutions containing 0.2 to 10 mg Mo per ml may be analyzed with an accuracy and precision of 0.1%. A sample dissolution and pretreatment procedure is described which is especially suitable for the analysis of alloys containing tungsten and rhenium. Rhenium is removed by volatilization. Tungsten is not separated and does not interfere in the determination. Moderate amounts of $Cl^-$, $ClO_4^-$, $NO_3^-$, and $PO_4^{3-}$ can be tolerated. Fe(III), U(VI), and Cu(II) interfere quantitatively in the coulometry, but small amounts can be removed during the sample pretreatment. Correction for Fe(III), Cu(II), Bi(III), and Ti(IV) interference may be made by reoxidation at +0.25 V vs. SCE. (auth)

**44994** GAS ANALYSIS BY MODULATED MOLECULAR BEAM MASS SPECTROMETRY. Olander, D. R.; Waddel, W. W. (Univ. of California, Berkeley). Anal. Chem., 40: 1687-93(Sept. 1968). (UCRL–17866(Rev.)).

A system for mass spectrometric determination of trace constituents in gases which uses a molecular beam inlet system was built and tested. Modulation of the sampling molecular beam permitted the use of phase sensitive detection methods, which improved the signal-to-noise ratio and reduced the interference caused by background gases in the vacuum chamber. The system was tested by analyzing natural oxygen gas for the various isotopic combinations. The 1.5 ppM $^{17}O^{18}O$ isotope was measured with a relative error of 5%. The ultimate sensitivity of the technique is approximately 0.1 ppM. (auth)

**44995** CHROMATOGRAPHIC-SOLVENT EXTRACTION ISOLATION OF $^{249}Bk$ FROM HIGHLY RADIOACTIVE SOLUTIONS AND ITS DETERMINATION BY BETA COUNTING. Farrar, L. G.; Cooper, J. H.; Moore, F. L. (Oak Ridge National Lab., Tenn.). Anal. Chem., 40: 1602-4(Sept. 1968).

A small high-pressure ion exchange system was used with liquid–liquid extraction to achieve decontamination sufficient to permit the determination by beta counting of $^{249}Bk$ isolated from highly radioactive solutions. A high-pressure pump forces solutions through a column of Dowex 50 resin (20- to 40-μ-diam particles) at pressures from 1800 to 2500 psi. The eluent is a dilute aqueous solution of α-hydroxyisobutyric acid of pH 4.2. The eluted $^{249}Bk$ is purified by extraction into 2-thenoyltrifluoroacetone–xylene. In this way the $^{249}Bk$ is separated sharply from many elements including the actinides, fission products, and corrosion products. Separations can be effected at eluent flow rates as fast as 18 ml $cm^{-2}$ $min^{-1}$, thereby minimizing loading time, elution time, and radiation damage to the resin. High-pressure operation makes possible the use of a long column (~2 ft) having a small free column volume (~1 ml). (auth)

**44996** HEAT-SEALED POLYETHYLENE SAMPLE CONTAINERS FOR NEUTRON ACTIVATION ANALYSIS. Ehmann, W. D.; McKown, D. M. (Univ. of Kentucky, Lexington). Contract AT(40-1)-2670. Anal. Chem., 40: 1758-9(Sept. 1968). (ORO–2670-27).

A method for constructing low cost irradiation vials with airtight seals from ordinary polyethylene tubing is reported. The controlled shrinkage of heat-shrinkable polyolefin insulation tubing (Alphex FIT-221) is used as a means of compressing melted polyethylene to form a uniform seal. When a section of shrinkable tubing jacketing the end of an ordinary polyethylene tube is heated locally to its shrinkage temperature, it collapses the melted tubing walls to form an airtight seal. (J. G. B.)

**44997** EXAMINATION OF THE DISTURBING EFFECT OF PHOSPHORESCENCE AND AFTERPULSING IN MEASURING THE ABSOLUTE ACTIVITY OF SOFT β-EMITTING ISOTOPES. Fodor-Csanyi, Piroska; Szilagyi-Gyoeri, Erzesbet. Magy. Kem. Foly., 74: 235-6(May 1968). (In Hungarian).

When determining the absolute activity of soft β-emitting isotopes in a single-channel liquid scintillation counter by the so-called extrapolation method, the initial nonlinear part of the integral spectrum arises from the disturbing effect brought about by the phosphorescence of the sample container and that of the scintillation solvent. (auth)

**44998** NEUTRON-RESONANCE ANALYSIS OF SUBSTANCE ELEMENT COMPOSITION. Gambaryan, R. G.; Shtan, A. S. At. Energ. (USSR), 25: 111-17(1968). (In Russian).

Two methods of neutron resonance analysis (NRA) of substances, activation and absorption, are proposed. The analytical expressions and optimum criteria that characterize the neutron resonance absorption and multiple activation regime are obtained. Analysis selectivity experimental studies were carried out at different energies. The NRA selectivity was confirmed by silver determination in a sample with complex composition. (auth)

**44999** SPECTRAL-RESONANCE ANALYSIS OF NEUTRON MODERATION. Gambaryan, R. G.; Kazachenkov, Yu. N.; Shtan, A. S. At. Energ. (USSR), 25: 117-21(1968). (In Russian).

The activation analysis method based on physically well-studied phenomenon of practically simultaneous neutron moderation in a heavy moderator is proposed. It ensures the determination of elements by measuring the capture gamma rays emitted when resonance neutrons are being absorbed. The optimum sizes of moderators were calculated and an expression for total gamma quanta emitted when resonance neutrons are absorbed in a sample was obtained. Neutron density is calculated as a function of the moderator sizes for 1, 10, and 100-eV neutrons. (auth)

**45000** IMPROVEMENTS IN OR RELATING TO A METHOD OF DETERMINING, WITH THE AID OF A NEUTRON SOURCE, THE HYDROGEN CONTENT OF SAMPLES. Sanders, John Erskine; Carter, David Herbert (to United Kingdom Atomic Energy Authority). British Patent 1,124,758. Aug. 21, 1968. Filed Jan. 12, 1966.

A method for determination of H in organic samples is based on the thermalizing power of H atoms for neutrons above a certain energy level. The samples are placed between a neutron source and a thermal neutron sensitive device with an absorber having a high thermal neutron absorption cross section interposed between the source and the sample to cut off a high proportion of the thermal neutrons from the source. The activity due to the remaining neutrons thermalized by the hydrogen atoms is measured. (B. L. M.)

**45001** ACTIVATION ANALYSIS. Comar, Dominique; Le Poec, Claude (to Commissariat a l'Energie Atomique). British Patent 1,103,995. Feb. 21, 1968. Priority date Apr. 22, 1965, France.

An activation method is described for the isolation of activated iodine from other elements in the sample that are activated and for the determination of the iodine. The sample is irradiated, the iodine is then separated from other halogens by fractional distillation of an emulsion of an organic solvent and an aqueous solution of the iodine or by anion exchange separation, and the purified

solution of the iodine is stored in a loop for a predetermined period of time that is sufficient to obtain an accurate activity measurement by a counter associated with the loop. After measurement, the sample is discharged prior to admission of the next sample. (B.L.M.)

**45002** IMPROVEMENTS IN ACTIVATION ANALYSIS. Starnes, Peter Edward (to Hilger and Watts Ltd.). British Patent 1,124,992. Aug. 21, 1968. Filed Apr. 7, 1966.

A method and apparatus are described for the continuous irradiation and measurement of samples either in the form of fluids or solid particles suspended in fluids circulating through a closed loop system. The circulation process is continued until equilibrium between activation and decay is established. The desired analytical information concerning the composition of the sample is derived from the magnitude of the equilibrium constant value or values by reference to corresponding measurements with standard samples under the same conditions. (B.L.M.)

**45003** ANALYSIS OF ARSENIC IN MARINE OILS BY NEUTRON ACTIVATION. EVIDENCE OF ARSENO ORGANIC COMPOUNDS. Lunde, Gulbrand (Central Inst. for Industrial Research, Oslo). J. Amer. Oil Chem. Soc., 45: 331-2(May 1968).

A method is presented for determination of As in fish oils and was applied to the phospholipid fractions separated from codliver oil (Gadus morrhua) and herring oil (Clupea harengus). The oil fractions were separated on a silicic acid column by chloroform/methanol mixtures as eluting agents. After evaporation of the solvent the phospholipid fractions were transferred to polyethylene ampoules and irradiated in the nuclear reactor JEEP I (Kjeller, Norway) with a neutron flux of $\sim 2 \times 10^{12}$ neutrons $cm^{-2}$ $sec^{-1}$ for 24 hr. Arsenic and phosphorus standards ($As_2O_3$ and $(NH_4)_2HPO_4$) were irradiated at the same time. A 400-channel $\gamma$ spectrometer, with a 2 × 2-in. NaI crystal, was used for recording the induced activity in the samples. As it was difficult to avoid Na contamination of the samples during fractionation of the phospholipids, it was necessary to wait about 5 days before recording the activated arsenic, $^{76}As$. The activity of $^{24}Na$ ($T_{\frac{1}{2}}$ = 14 hr) was then reduced sufficiently to allow recording of the $^{76}As$ ($T_{\frac{1}{2}}$ = 26 hr). The As photo peak of 0.55 MeV was used for quantitative determination. After the $^{76}As$ activity had decayed the induced $^{32}P$ was measured directly by a proportional counter. Results indicated that the As appears as arsenoörganic compounds, 2 such compounds being evident in herring oil. (BBB)

**45004** MASS SPECTROMETRIC ISOTOPE ANALYSIS OF PLUTONIUM IN NEUTRON IRRADIATED URANIUM DIOXIDE. Inoue, Kiyoshi; Kobayashi, Tadao (Hitachi Ltd., Tokyo). Shitsuryo Bunseki, 16: 93-100(June 1968). (In Japanese).

A mass spectrometric method for analysis of $UO_2$ specimens irradiated to about 8,000 MWD/T for Pu is presented. The mass spectrometer was equipped with a thermal ionization double-filament source assembly. Even though some uncertainty exists, the variation of the ratio of Pu to U indicates a general trend of making maximum value of the simple filament temperature. (NSA of Japan)

**45005** TRITIUM ASSAY OF LABELLED ORGANIC COMPOUNDS BY THE FLOW MONITORING COUNTER. Barakat, M. F.; Zahran, A. H. (Atomic Energy Establishment, Cairo). Z. Anal. Chem., 239: 93-9(1968).

A sensitive, simple, and cheap counting system for the radioactivity assay of tritiated organic compounds is described. The organic labelled material was converted into carbon dioxide and tritiated hydrogen in an ignition-reduction quartz tube filled with copper oxide and iron fillings. Tritiated hydrogen was then assayed while passing through a flow monitoring counter. Application of the counting system greatly decreased the analysis time as compared with other techniques in which internal filling gas counters were used. Results showed that the counting system could readily measure activities as low as fractions of a nCi per mg of tritiated organic compound. The counting system could be used for the assay of organic compounds doubly labeled with tritium and $^{14}C$. (auth)

**45006** COMPUTER TECHNIQUES IN LABORATORY INVESTIGATIONS. APPLICATION TO THE ASSAY OF RADIOACTIVITY LIQUID SCINTILLATION COUNTING. Felts, J. M.; Mayes, P. A. (Royal Veterinary Coll., London). J. Physiol. (London), 196: 16p(May 1968).

Calculation of data resulting from the counting of large numbers of samples in automatic liquid scintillation counters by the use of a computer program is described. The program, written in FORTRAN IV, will calculate the data from 1 or 2 isotopes counted simultaneously. By relays, data from a Tri-Carb Liquid Scintillation Spectrometer are punched automatically in cards using an IBM 026 Printing Card Punch. The input data consisting of 3 cycles of counting data are arranged sequentially. The program examines the data to determine if cards are missing or if extra cards are present and if necessary, prints out appropriate error messages. For each sample, the 3 cycles of counts are examined for gross variations, and the data are rejected if they do not pass a predetermined test. If the data are accepted, the cpm values are calculated. A test is carried out to determine which isotopes are present, the background is subtracted, and, if there are data from an external standard, corrections are made for quenching using constants obtained in a separate experiment. The calculated data are corrected for efficiency of counting and printed out together with ancillary information, such as the S.E.M. (standard error of the mean) for the counts in each channel. (BBB)

**45007** ACTIVATION ANALYSIS IN METALLURGICAL CHEMISTRY. Albert, Philippe. Sci. Progr.-Nature, No. 3398, 201-9(June 1968). (In French).

The principle of activation analysis is briefly described. The techniques used are then discussed: preparation of the sample for irradiation, irradiation by thermal or fast neutrons, preparation of the irradiated sample for measurement, and detection and measurement of the induced radiation. (J.S.R.)

**45008** STUDY FOR THE ASSISTANCE OF ACTIVATION ANALYSIS OF ISOTOPIC FRACTIONATION OF RARE EARTH OXIDES. Massart, D. L.; Hoste, J. (Instituut Nucleaire Wetenschappen, Ghent). Bull. Soc. Chim. Belg., 77: 165-70 (Mar.-Apr. 1968). (In French).

Samples used in activation analysis must have an isotopic distribution identical to the natural element; several samples of rare earth oxides were examined by activation analysis to determine if a variation in isotopic distribution could be detected. Thus the ratios of Gd, which produces several isotopes (3 Gd, 1 Tb), were examined and the $^{161}Tb/^{153}Gd$ activity ratio determined. Likewise, Yb produces 3 isotopes of Yb and 1 Lu on irradiation, and the $^{169}Yb/^{175}Yb$ ratio was determined. For Gd the ratio is 1.03/0.03 for the mineral and 1.05/0.03 for the processed sample (after ion exchange purification). Analysis of Yb samples was done by examining decay curves for the mineral and the processed sample, because of concentration effects. In both samples the rate of decay was similar, and the ratio between sample and mineral remained constant for 42 days at 9.3. Therefore, no important isotopic fractionation occurs in these elements on processing them. It is suggested that for isotopes of the rare earths in general, only very slight fractionation may be expected. (BBB)

**45009** EFFECT OF FLUX VARIATIONS IN NEUTRON GENERATORS ON THE ACCURACY OF ACTIVATION ANALYSIS. Vass, Szabolcs; Vorsatz, Bruno. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 225-30(1968). (In Hungarian).

A calculation method is described that evaluates the error induced in activation analysis by the monotonical decrease in fast neutron flux due to target aging, or by the periodical fluctuation of the flux, if rotary targets are used. (auth)

**45010** INTERACTION OF LANTHANIDE AND NITRATE IONS IN SOLUTION. II. THE RELATIVE INTERACTION STRENGTH WITH WATER AND NITRATE IN ORGANIC SOLVENTS. Abrahamer, I.; Marcus, Y. (Soreq Nuclear Research Centre, Yavne, Israel). J. Inorg. Nucl. Chem., 30: 1563-75 (1968).

The competition of water, nitrate ions, and solvent for interaction with lanthanide ions was studied by measuring the absorption spectra of solutions containing suitable combinations of these components. The role of the water in lanthanide nitrate extracts by TBP and by a tri-alkylammonium nitrate solution was also studied. The following affinity series of ligands and solvents for lanthanide ions was obtained: Dimethyl formamide > TBP > $NO_3^-$ ~ $H_2O$ > EtOH > dioxane. (auth)

**45011** PROPERTIES OF ZIRCONIUM COMPOUNDS LIKELY TO BE OF INTEREST TO THE ANALYTICAL CHEMIST. Blumenthal, Warren B. (National Lead Co., Niagara Falls, N. Y.). Talanta, 15: 877-82(Aug. 1968).

A review is given of zirconium chemistry, with emphasis on the features underlying the chemical methods of determining this element, and the application of zirconium compounds in the analytical chemistry of other species. (auth) (UK)

**45012** DIRECT COMPLEXIMETRIC TITRATION OF INDIUM, THALLIUM, AND THORIUM WITH EDTA USING IRON-N-BENZOYL-N-PHENYLHYDROXYLAMINE AS INDICATOR. Das, H. R.; Shome, S. C. (Presidency Coll., Calcutta). Anal. Chim. Acta, 43: 140-2(Oct. 1968).

Iron-N-benzoyl-N-phenylhydroxylamine (BPHA) can be used

as indicator in the EDTA titration of small amounts of indium, thallium(III), and thorium in the pH interval 1.5 to 6.0, the optimum range being 2.0 to 4.0. The end point, indicated by a change of color from reddish-violet to colorless, is very sharp. The interference of large amounts of Al, Hg, Cr, Mn, An, Mg, Ni, Ce, U, and Ca is avoided by this direct titration. However, trace amounts of Ti(IV), Mo(VI), and V(V) interfers. The limits for the titrimetric determination of In and Tl were found to be 2.5 and 9.2 mg respectively; Th could be titrated at higher concentrations (35 mg or more). (D.H.M.)

**45013** DETECTION OF TRACES OF BARIUM OR STRONTIUM BY INDUCED PRECIPITATION. Vaughan, A.; Townshend, A. (Univ. of Birmingham, Eng.). Anal. Chim. Acta, 43: No. 1, 134-6(Oct. 1968).

A test for the presence of Ba or Sr was developed and a definite mechanism postulated. To two test tubes 2 ml of lead sulfate solution and 1 ml of test solution or water (as a blank) are added. Two ml of absolute ethanol from a syringe is injected into the blank and then into the test solution. The appearance of a precipitate in the test solution at least 30 sec before that in the blank indicates the presence of Ba or Sr. The sensitivity of the test is Ba: 0.1 μg, dilution $1:10^7$ in test solution; Sr: 0.2 μg, dilution $1:5\times10^6$ in test solution. There was no interference from 1-mg amounts of $Ag^+$, $Cd^{2+}$, $Cl^-$, $Co^{2+}$, $Cr^{3+}$, $Cu^{2+}$, $Fe^{2+}$, $Fe^{3+}$, $Hg^{2+}$, $I^-$, or $Pb^{2+}$. Up to 0.1 mg of $Ca^{2+}$ and $F^-$ could also be tolerated. (D.H.M.)

**45014** DETERMINATION OF IMPURITIES IN URANIUM COMPOUNDS BY ATOMIC ABSORPTION. Walker, C. R.; Vita, O. A. (Goodyear Atomic Corp., Piketon, Ohio). Anal. Chim. Acta, 43: No. 1, 27-35(Oct. 1968).

A method is described for the determination of 14 elements (Al, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Na, Zn) in uranium and uranium compounds by atomic absorption spectroscopy. A sample is dissolved in 6 to 8 N nitric acid, from which the uranium is selectively removed by a single extraction with tributyl phosphate. The aqueous layer is evaporated to dryness and the residue is re-dissolved in 0.2 N hydrochloric acid. Any or all of the elements can then be determined in this one solution by atomic absorption spectroscopy. The limits of error in the analyses are less than 10%. Thus, the method gives of about the same precision as colorimetric procedures, and it is much more precise than emission spectroscopy. (auth)

**45015** EXTRACTIVE PHOTOMETRIC DETERMINATION OF NIOBIUM. Ozerova, G. P.; Mel'chakova, N. V.; Nosova, L. I.; Peshkova, V. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 89-92(May-June 1968). (In Russian).

The conditions of niobium extraction by benzoylacetone from solutions of hydrochloric acid were investigated. The extractive photometric method for niobium determination in the presence of zirconium with ratio Nb : Zr = 1 : 20 was developed. (auth)

**45016** SELECTIVE OXIDATION OF CERIUM(III) BY PERMANGANATE AND ITS DIRECT AMPEROMETRIC DETERMINATION. Bogovina, V. I.; Usatenko, Yu. I.; Maltsev, V. F. (Dnepropetrovsk Chemical-Engineering Inst., USSR). Zh. Anal. Khim., 23: 1152-7(Aug. 1968). (In Russian).

Complex formation of cerium(III) with pyrophosphate and fluoride ions was studied by a photometric method. The composition and the concentration instability constants of the complexes were found. The reaction kinetics of cerium(III) oxidation by potassium permanganate in sulfuric acid medium (3 N $H_2SO_4$) was studied in the presence of potassium pyrophosphate and ammonium fluoride. The selective oxidation of cerium(III) in an acid medium by potassium permanganate in the presence of elements of variable valency was carried out using potassium pyrophosphate and ammonium fluoride as the complex forming substances. Methods were developed for the direct amperometric determination of cerium as well as cerium and vanadium in cast iron, steels, alloys based on chromium, nickel, aluminum, and magnesium (from 0.005 to 70.0%) with a relative error not more than 5.0%. (auth)

**45017** POLAROGRAPHIC DETERMINATION OF EUROPIUM AND YTTERBIUM IN PREPARATIONS OF THE RARE EARTH ELEMENTS. Ilkova, S. B.; Barkovskii, V. F.; Chistyakova, E. A. (Ural State Univ., Sverdlovsk, USSR). Zh. Anal. Khim., 23: 1158-63(Aug. 1968). (In Russian).

A polarographic method was developed for determining europium and ytterbium in oxides and concentrates of the rare earth elements. The sensitivity of determinations is 0.005 g/liter of $Eu_2O_3$ and 0.001 g/l of $Yb_2O_3$. The variation coefficient is within 3 to 18% at the concentrations of $Eu_2O_3$ and $Yb_2O_3$ from $5\times10^{-3}$ to 100%. (auth)

**45018** DETERMINATION OF PLUTONIUM IN SULFURIC ACID SOLUTION. Nemodruk, A. A.; Kochetkova, N. E. Radiokhimiya, 10: 324-8(1968). (In Russian).

During the study of the effect of the content of sulfate on the photometric determination of Pu(IV) with Arsenazo III in 6M $HNO_3$, it was established that an increase of the concentration of Arsenazo III from $4.8\times10^{-5}$M to $3.0\times10^{-4}$M reduced the interfering effect of sulfate. At an Arsenazo III concentration of $3.0\times10^{-4}$M, the presence of 0.6 g-ion/l $SO_4^{2-}$ did not impede the determination of Pu(IV). The proposed method included the preliminary concentration of the solution to be analyzed with sulfuric acid in order to convert all valence states of Pu into the tetravalent state and its subsequent determination with Arsenazo III in 6M $HNO_3$. The method is recommended not only for the determination of Pu(IV) in sulfuric acid solution but also for the determination of Pu occurring in different valence states in solutions of other acids, easily violatilized during boiling with sulfuric acid (nitric, hydrochloric, perchloric, acetic, and hydrofluoric acids). (tr-auth)

**45019** NEUTRON ACTIVATION ANALYSIS OF HIGH-PURITY SELENIUM. PART III. DETERMINATION OF PHOSPHORUS, SULFUR, AND CHLORINE. Ballaux, C.; Dams, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 43: No. 1, 1-11(Oct. 1968).

Chlorine was determined in selenium by irradiation of 2-g samples for 37 min at a flux of $8\times10^{10}$ n/cm²/sec. Chlorine was volatilized from hot concentrated nitric acid and precipitated as silver chloride. The isotope $^{38}Cl$ ($T_{\frac{1}{2}}$ = 37.3 min) was counted by γ-spectrometry. Sulfur and phosphorus were determined by irradiating 50-mg samples with and without cadmium shielding for 4 days at a thermal flux of $6\times10^{12}$ n/cm²/sec and a fast flux of $4\times10^{11}$ n/cm²/sec. The matrix activities were separated by distillation from sulfuric acid - hydrobromic acid at 200 to 220°C. The isotope $^{32}P$ ($T_{\frac{1}{2}}$ = 14.3 d) was then precipitated, together with phosphate carrier, as ammonium phosphomolybdate, and counted with a G.M. tube. Amounts of 0.4 to 1 ppM chlorine, 65 to 520 ppB phosphorus and 1.5 to 4.6 ppM sulfur were found in high-purity selenium samples. (auth)

**45020** DETERMINATION OF OXYGEN IN MOLYBDENUM SAMPLES BY ACTIVATION WITH NEUTRONS WITH ENERGIES OF 14 MeV. Abdurakhmanova, S. R.; Kireev, V. A.; Navalikhin, L. V.; Talanin, Yu. N. (Inst. of Nuclear Physics, Tashkent). Zh. Anal. Khim., 23: 1188-91(Aug. 1968). (In Russian).

A method is described for the determination of oxygen in molybdenum samples. The sensitivity of the method is about $10^{-4}$% of oxygen in samples of 20 g. The accuracy of the method is ±10%. This high accuracy was achieved due to an improved method of monitoring of the neutron flux. The analysis of one sample containing about $10^{-3}$% of oxygen takes not more than 10 min. (auth)

**45021** DETERMINATION OF RADIOACTIVE STRONTIUM CONTENT IN FALLOUT AND MUD SAMPLES. Polgar, Erzsebet; Kurczne, Csikyildiko. Magy. Kem. Lapja, 23: 341-3(June 1968). (In Hungarian).

Some experiments are presented which were performed for the determination of the $^{90}Sr$ contents of the fallout and of some mud samples. A method, formerly used for the determination of the active Sr content of atmospheric rainfall, was modified. Using this modified procedure the investigations, which would be otherwise rather laborious, can be performed rather simply and within a relatively short time. (auth)

**45022** DETERMINATION OF SCANDIUM IN SEA-WATER BY ATOMIC-ABSORPTION SPECTROSCOPY. Chau, Yiu-kee; Wong, Pui-yuen (Chinese Univ. of Hong Kong). Talanta, 15: 867-70 (Aug. 1968).

A method for the determination of scandium in seawater at the submicrogram level was developed. Scandium is coprecipitated with iron(III) hydroxide at pH 8 to 9, and then separated from the iron by ion exchange. The final concentration is achieved by extracting the scandium into a solution of oxine in butanol. A nitrous oxide - acetylene flame is used for the determination by atomic-absorption spectroscopy. Recoveries of 99 to 100% are obtained. The effect of storage of the solutions before analysis was investigated by radiometric techniques with $^{46}Sc$. The scandium concentration in surface waters of the South China Sea was found to be 0.01 ± 0.005 μg/l. (auth) (UK)

**45023** DETERMINATION OF SCANDIUM BY ATOMIC ABSORPTION. Kriege, Owen H.; Welcher, G. G. (Pratt and Whitney Aircraft, Middletown, Conn.). Talanta, 15: 781-7(Aug. 1968).

A comprehensive study was made of the determination of scandium by atomic absorption. In addition to the instrumental variables such as flame-height, slitwidth, and lamp current, a number of solution variables were studied, including the effect of anions

(chloride, sulfate, nitrate, and fluoride), organic solvents, and other metals on the determination of scandium. Standard conditions were established for the detection of minor amounts of scandium in a wide variety of materials, including complex alloys of iron, nickel, aluminum, magnesium, and the rare earths. (auth) (UK)

## Inorganic, Organic, and Physical Chemistry

*Refer also to abstracts 45016, 45108, 45140, 45147, 45166, 46088, and 46255.*

**45024** (AERE-R-5793) CHAFFER: A COMPUTER PROGRAMME TO EVALUATE THERMODYNAMIC DATA FOR CHEMICAL REACTIONS OVER A RANGE OF TEMPERATURES. Huber, R. A. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 20p. Dep. CFSTI. UK 3s. 0d.

A computer programme CHAFFER is described, which is designed to evaluate various thermodynamic data for any gas-gas or gas-solid reaction over a range of temperatures, given the thermodynamic constants for each species of the reaction. The main features of the programme are the flexible data input format, the extensive diagnostics provided to flag data errors, and the option of checking the stoichiometry of a reaction. This latter facility is at present limited to the C, H, O, N system, but this should cover most envisaged applications. (auth) (UK)

**45025** (NIJS-R-524) ON THE SYSTEM URANIUM TETRAFLUORIDE–HYDRAZINE. Glavic, P.; Slivnik, J. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Feb. 1968. 5p. (CONF-670447-2). Dep.

From Conference on Inorganic Fluorine, Leicester, England.

The effects of water on the reaction of $UF_4$ with hydrazine were examined. The addition product $UF_4 \cdot nN_2H_4$ was observed in the reaction. Another product identified was $N_2H_4F$. (M.C.G.)

**45026** (ORNL-TM-2306) A FEASIBILITY STUDY OF THE CONVERSION OF $PuF_6$ TO $PuO_2$ BY CHEMICAL VAPOR DEPOSITION. Robinson, W. C. Jr.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A program was undertaken to establish the feasibility of converting $PuF_6$ to $PuO_2$ in a one-step process by chemical vapor deposition techniques. The process is analogous to the $UF_6$ conversion process and involves the reaction of $PuF_6$ vapor, hydrogen, and $H_2O$. A remote apparatus with facilities for fluorination of $PuF_4$ to $PuF_6$ and subsequent conversion of $PuF_6$ to $PuO_2$ was designed, constructed, and the feasibility experiments were completed. X-ray analyses of the powder product confirmed the presence of $PuO_2$ only. (auth)

**45027** (RFP-Trans-41) CYCLOPENTADIENYL COMPLEXES OF MOLYBDENUM, TUNGSTEN, AND URANIUM, AND THE REACTION OF CYCLOPENTADIENYL MANGANESE TRICARBONYL WITH SODIUM. Hristidu, Yani (Munich Univ. (West Germany)). Translation of Thesis. 99p. Dep. CFSTI.

Studies were made to obtain further insight into the bonding relations of the pure metallic cyclopentenes. The special goal was to investigate the question of the existence of uncharged metallic cyclopentadienyls of the sixth sub-group, especially those of Mo and W, and the possibility of stabilizing their low oxidation stages via the formation of complexes. Extensive investigations of U were also conducted, based on an earlier description of a tricyclopentadienyl uranium chloride, to permit the preparation of further cyclopentadienyl complexes. Another problem investigated was the reduction of cyclopentadienyl manganese tricarbonyl $C_5H_5Mn(CO)_3$ in an ammonium system with sodium. (P.C.H.)

**45028** (UCRL-18043) INORGANIC MATERIALS RESEARCH DIVISION ANNUAL REPORT, 1967. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1968. Contract W-7405-eng-48. 247p. Dep. CFSTI.

Four sections are included; separate abstracts were prepared for each. (P.C.H.)

*For abstracts of individual papers see: 45029, 45745, 45799, and 46199.*

**45029** (UCRL-18043, pp 7-105) CHEMISTRY. (Univ. of California, Berkeley).

Developments are reported for studies in: inorganic chemistry; chemical thermodynamics; solid-state chemistry and physics; electrochemistry; physical chemistry; and nuclear science. (P.C.H.)

**45030** (UCRL-50446) DYNAMIC COMPRESSIVE RHEOLOGICAL BEHAVIOR OF A BRITTLE, STRAIN RATE SENSITIVE, POLYCRYSTALLINE, ORGANIC SOLID. Wasley, R. J.; Walker, F. E. (California Univ., Livermore. Lawrence Radiation Lab.). July 1, 1968. 34p. Dep. CFSTI.

The rheological behavior of a brittle, strain-rate sensitive, polycrystalline, organic solid explosive (pressed TNT) was investigated under conditions of one-dimensional (in the macroscopic sense) compressive strain. The results are reported under compressive loading conditions of both uniaxial strain and uniaxial stress. The work is discussed in four separate but interrelated sections. The wave structure of the uniaxial strain compressive shock within the specimen was deduced by examining quartz crystal pressure transducer stress-time records for both input and output stress disturbances. It was observed that an elastic precursor wave forms in the specimen if the driving stress (the "plastic follower" wave) is below approximately 10 kbar. Stress-strain-variable strain rate curves were experimentally determined in uniaxial strain for two different specimen thicknesses using the quartz crystal results. All sets of curves were found to be related to specimen thickness in a fashion suggesting a work-hardening mechanism. By using the results from an associated uniaxial stress investigation on the same material, shock hydrostats were estimated at the lower strain levels from the stress-strain-constant strain rate curves most closely in agreement with the Hugoniots. A numerical study indicated the transducer data previously mentioned were not significantly affected by wave reflections and interactions with regard to representing (in a valid fashion) the structure of the emerging disturbance. (P.C.H.)

**45031** HYDROLYSIS OF THE URANIUM OXYCHLORIDES $UOCl_3$ AND $UO_2Cl_2$. Eliseev, S. S. (Inst. of Chemistry, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR, 11: No. 3, 25-8 (1968). (In Russian).

The hydrolysis of the uranium chloride oxides $UOCl_3$ and $UO_2Cl_2$ was studied by the infrared spectroscopic method. It was assumed that in the $UOCl_3$ molecule both "isolated" bonds of the $U \cong O$ or $U \cong O$ and polymer chains ...UOUO... can exist. The $U \cong O$ bonds are partially destroyed as a function of the degree of hydrolysis and replaced by the bridge bonds ...UOUO.... In the infrared spectrum of $UO_2Cl_2$ wide intense bands are absent in the region from 600 to 1000 $cm^{-1}$ even during strong hydrolysis. Narrow intense bands in the region from 800 to 1000 $cm^{-1}$ indicate the existence of only isolated $U \cong O$ bonds. The intense bands with maximum at 430 $cm^{-1}$ can refer to U–Cl bonds. (tr-auth)

**45032** COMPOUNDS OF TECHNETIUM(IV) AND RHENIUM (IV) WITH 2,2'-DIPYRIDYL AND 1,10-PHENANTHROLINE. Shukla, Shyama Kant (Univ., Rome. CNR, Rome). Ric. Sci., 38: 133-5(Feb. 1968).

2,2'-Dipyridylium compounds of hexachlorotechnetate(IV) and hexachlororhenate(IV) were prepared and a comparative study of some of their properties carried out. The experimental data were found to be consistent with the formula $[C_{10}H_8N_2H_2]MCl_6$, where M = Tc(IV) or Re(IV). 1,10-phenanthroline was found to give compounds of color and chemical behavior similar to those of 2,2'-dipyridylium hexachlorocompounds of the two elements. (auth)

**45033** MEASUREMENT OF THE SOLUBILITY OF HEAVY WATER IN CARBON TETRACHLORIDE BY REVERSE ISOTOPIC DILUTION. Epherre, Pierre; Roth, Etienne (Conservatoire National des Arts et Metiers, Paris). Bull. Soc. Chim. Fr., No. 6, 2291-2(June 1968). (In French).

A method is proposed that enables the measurement of solubility to be carried out without stringent precautions. The carbon tetrachloride does not need to be dried. The obtained value is $9 \pm 0.5 \cdot 10^5$ gram per gram at room temperature in good agreement with previous determinations for $H_2O$ solubility in $CCl_4$. (auth)

**45034** ON THE FORMATION OF ALKALINE URANATES IN AQUEOUS SOLUTIONS. A GENERAL REVIEW. Nguyen-Quy-Dao, M. (Ecole Normale Superieure, Paris. Faculte des Sciences, Paris). Bull. Soc. Chim. Fr., No. 6, 2403-7(June 1968). (In French).

A review on the subject includes: behavior of U(VI) in aqueous solution; the reaction of bases other than ammonia with uranyl solutions; and precipitation reactions of solutions of uranyl salts by ammonia. It was concluded from the review that in spite of the many studies concerning basic uranates, the formulas proposed are very diverse and controversial. This is explained in part by the fact that the nature of the compounds obtained probably depends on the conditions of preparation. (61 references). (P.C.H.)

**45035** CONTAINMENT OF MOLTEN FLUORIDES IN SILICA: EFFECT OF TEMPERATURE ON THE SPECTRUM OF $U^{4+}$ IN

MOLTEN LiF–$BeF_2$ MIXTURES. Bamberger, C. E.; Baes, C. F.; Young, J. P. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Inorg. Nucl. Chem., 30: 1979-81(Aug. 1968). (ORNL-P-3396).

The effect of $SiF_4$ overpressure on the chemical attack on silica containers by molten LiF–$BeF_2$ mixtures was evaluated. $UF_4$, which would produce a less soluble oxide than $BeF_2$, was used as an "internal indicator" of the extent of the attack on $SiO_2$. Spectrophotometric studies showed no significant attack on the silica container at $SiF_4$ overpressures of ~400 mm. Some melts were maintained as long as one month without any noticeable damage to the container except loss of transparency. The precision of quantitative spectral measurements derived for U(IV) was improved by comparing solutions of U(IV) in molten LiF–$BeF_2$ in quartz and silica cells. A high solubility of $SiF_4$ in some fluoride melts could cause more extensive attack of the silica. (M.C.G.)

**45036** THERMAL DECOMPOSITION OF FLUORIDE COMPLEXES OF THORIUM WITH HYDRAZINE AND HYDROXYLAMINE. Satpathy, K. C. (G. M. Coll., Sambalpur, India); Sahoo, B. Curr. Sci. (India), 37: 435-6(Aug. 5, 1968).

Fluoride complexes of thorium with hydroxylamine and hydrazine were prepared and subjected to thermal decomposition in vacuum at 300 to 400°C. The complexes underwent rapid decomposition with the elimination of various gaseous products and yielded thorium fluoride, $ThF_4$, in the anhydrous state. (J.G.B.)

**45037** STEPWISE FORMATION OF URANIUM(VI) COMPLEXES WITH SULPHONATED PHENOLIC COMPOUNDS. Banerjee, Amitav; Dey, Arun K. (Univ. of Allahabad, India). Anal. Chim. Acta, 42: 473-9(Sept. 1968).

The metal complexes of uranium(VI) with disodium 2-naphthol-3,6-disulfonate and 7-amino-1-naphthol-3,6-disulfonic acid were studied by the established potentiometric techniques of Bjerrum and Irving and Rossotti. The step-wise protonation constants of the ligands and the step-wise stability constants of the uranyl complexes were determined in 0.1 M sodium perchlorate media at 25°C. (auth)

**45038** STABILITY CONSTANTS OF SOME METAL COMPLEXES OF TRIETHYLENETETRAMINEHEXA-ACETIC ACID AND COMPLEXOMETRIC TITRATION OF RARE EARTHS AND OTHER METALS. Soucek, Donald A.; Cheng, K. L.; Droll, Henry A. (Univ. of Missouri, Kansas City). Talanta, 15: 849-50(Aug. 1968).

The stability constants of some nonprotonated 1 : 1 metal complexes of triethylenetetraminehexaacetic acid are reported; log K values are Cd 19.8, Co(II) 20.4, Ni 19.9, Pb 19.5, Sm(III) 24.3, Zn 20.1. (auth) (UK)

**45039** SECONDARY STANDARDS. PART II. ACETYLACETONATES. Chalmers, Robert A.; Umar, Mohammad (Univ. of Aberdeen, Scotland). Anal. Chim. Acta, 42: 357-64(Sept. 1968).

The preparation of several acetylacetonates is described, the novel feature being that the organic reagent is added in substoichiometric amount. Several of the compounds are obtainable 99.9% pure or better, and are proposed as secondary standards for the metals they contain or for elementary analysis. These are the copper(II), chromium(III), zinc, cadmium, magnesium, thorium, cobalt(III), iron(II) and calcium compounds. Cobalt(II) and nickel dipyridine acetylacetonates are also proposed. Aluminum and beryllium acetylacetonates are suitable as routine test materials. (auth)

**45040** THE INFRA-RED SPECTRA OF COMPLEXES OF BERYLLIUM WITH TRI-n-OCTYLPHOSPHINE OXIDE AND Di(2-ETHYLHEXYL) PHOSPHORIC ACID. Smythe, L. E. (Australian Atomic Energy Commission, New South Wales); Whateley, T. L.; Werner, R. L. J. Inorg. Nucl. Chem., 30: 1553-61(July 1968).

The interaction of beryllium with tri-n-octylphosphine oxide (TOPO) and with di(2-ethylhexyl) ester of phosphoric acid (HDEHP) was studied by ir spectroscopy. For beryllium nitrate–TOPO solutions, the small shift (48 $cm^{-1}$) in $\nu$PO and the small splitting (195 $cm^{-1}$) of the nitrate band in relation to the large ionic potential (e/r) of the beryllium ion are explained on the basis of steric hindrance. A similar situation is found in the aluminum nitrate–TOPO system. In the spectrum of $Be(DEHP)_2(HDEHP)_2$ a very broad band in the region 1700 to 800 $cm^{-1}$ indicates the presence of strong, symmetrical or near-symmetrical hydrogen bonding. $Be(DEHP)_2$ occurs at higher beryllium loadings, and bands at 763 and 685 $cm^{-1}$ are shown to be Be–O vibrational modes. The system $Fe^{3+}$-HDEHP shows similar features, and studies were made of the effect of deuteration and low temperatures on the spectrum of $Fe(DEHP)_3(HDEHP)_3$. (auth) (UK)

**45041** INFRA-RED SPECTRA AND STRUCTURE OF THE RARE-EARTH BENZOATES. Taylor, M. D.; Carter, C. P.; Wynter, C. I. (Howard Univ., Washington, D. C.). J. Inorg. Nucl. Chem., 30: 1503-11(July 1968).

The ir absorption spectra for benzoic acid and the benzoates of Na, Pr, Nd, Er, and Tm were measured over the frequency range 3400 to 200 $cm^{-1}$. Frequencies for the rare earth benzoates are reported for the first time. Previously published data and observations are used to suggest several band assignments. The C=C and C–H bands of the phenyl nucleus are not greatly changed in the lanthanon salts. The various bands associated with the carboxylate group motions are considerably altered in the salts. The modifications of several of the bands are interpreted as indicating that the benzoate ion is serving as a bidendate ligand, and the lanthanon ion is 6-coordinated in lanthanon benzoates. Such an interpretation accounts for some of the properties of these benzoates, such as: solubility, ease of dehydration, and conductance. Benzoic acid, sodium benzoate, the light lanthanon benzoates, and the heavy lanthanon benzoates can be distinguished from each other in terms of their ir spectra. The bands useful for such distinctions are reported. (auth) (UK)

**45042** KINETICS OF DEUTERIUM EXCHANGE OF FURAN AND METHYLFURANS IN DIMETHYLSULFOXIDE. Shatenshtein, A. I.; Kamrad, A. G.; Shapiro, I. O.; Ranneva, Yu. I.; Hiller, S. A. Chem. Heterocycl. Compounds (USSR) (Engl. Transl.), 2: 489-92 (Sept.-Oct. 1966).

To compare H mobility in CH bonds differing markedly in reactivity, exchange rates between 2D-furan and K and Li tert-butoxides in 0.4 M solution were measured. The rate constants show that there is a 2000-fold difference in catalytic activity between the 2 butoxides. Deuterium exchange average rate constants were as follows: 2D-furan, 0.4 M tBuOLi, $2.1 \times 10^{-7}$ $sec^{-1}$ at 25°C; 2D-furan, 0.4 M tBuOK, $5.5 \times 10^{-4}$ $sec^{-1}$ at 25°C; 3D-furan, 0.4 M tBuOK, $9.8 \times 10^{-7}$ $sec^{-1}$ at 25°C; 3D-furan, 0.4 M tBuOK, $1.2 \times 10^{-5}$ $sec^{-1}$ at 50°C; $5CH_3$-2D-furan, 0.4 M tBuOK, $5.8 \times 10^{-5}$ $sec^{-1}$ at 25°C; $3CH_3$-2D-furan, 0.4 M tBuOK, $5.8 \times 10^{-5}$ $sec^{-1}$ at 25°C. Synthetic procedures for preparation of the D compounds from chloromercury compounds are listed. (BBB)

**45043** ADSORPTION OF TRACE ELEMENTS IN SEA WATER ON VARIOUS CONTAINER SURFACES. Robertson, D. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Anal. Chim. Acta, 42: 533-6(Sept. 1968).

A study using radioactive tracers was made to determine the optimum conditions for storing seawater and to describe the adsorption behavior of eleven trace elements, Sc, Fe, Zn, Co, Sr, Rb, Ag, In, Sb, Cs, and U in seawater samples stored in polyethylene bottles, pyrex glass bottles, and in polyethylene bottles containing sufficient HCl to lower the pH of seawater to about 1.5. The behavior of these tracers stored in various containers showed that serious losses of In, Sc, Fe, Ag, U, and Co can occur by their absorption onto container surfaces. It appears that the optimum conditions for storing seawater consists of immediately acidifying the seawater to a pH of about 1.5 storing the samples in polyethylene bottles. It is recommended that the polyethylene bottles be well rinsed before use with purified HCl or $HNO_3$ to remove traces of Fe or other materials on the surface of the bottles. It is possible that freezing the acidified seawater samples may retard the absorption of Sc and U onto polyethylene surfaces. (D.H.M.)

**45044** GASEOUS METAL NITRIDES. III. ON THE DISSOCIATION ENERGY OF THORIUM MONONITRIDE AND PREDICTED DISSOCIATION ENERGIES OF DIATOMIC GROUP III-VI TRANSITION-METAL NITRIDES. Gingerich, Karl A. (Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys., 49: 19-24 (July 1, 1968).

Mass-spectrometric evidence for the existence of gaseous thorium mononitride over a nitrogen-containing thorium–boron–phosphorus system was obtained. The enthalpies $\Delta H^\circ_{298}$ of the reactions $ThN(g) \rightarrow Th(g) + 0.5N_2(g)$ and $ThP(g) + 0.5N_2(g) \rightarrow ThN(g) + 0.5P_2(g)$ were calculated from the experimentally determined partial pressures of the reactants as 23.1 ± 6.0 and 7.0 ± 5.0 kcal/mole. Combined with published thermodynamic data these reaction enthalpies yield the respective dissociation energy $D^\circ_{298}$, the heat of formation, $\Delta H^\circ_{f,298}$, and the heat of sublimation, $\Delta H^\circ_{s,298}$ of 138.0 ± 8, 112.5 ± 7.5, and 203.1 ± 10 kcal/mole for gaseous ThN. The dissociation energies of the diatomic nitrides of the Group III–IV transition metals were estimated on the basis of empirical correlations by Colin and Goldfinger and by Pauling. The values, which range from 96 kcal/mole for CrN to 145 kcal/mole for TaN, are explained in terms of a strong ionic contribution to the bonding. On the basis of the calculated dissociation energies and published thermodynamic data, the corresponding heats of formation and heats of sublimation were also estimated. (auth)

**45045** ELEMENT 103 OF THE PERIODIC SYSTEM. (REVIEW). Donets, E. D.; Druin, V. A.; Mikheev, V. L. At. Energ. (USSR), 25: 87-94(1968). (In Russian).

Results of works on the synthesis and the study of the properties of element 103 isotopes were analyzed. It was concluded that the most reliable and complete data have been obtained for the isotope 256. The half-life of this isotope is about 35 sec and its alpha emission spectrum is complicated and lies between 8.3 and 8.5 MeV. To get the same degree of unambiguity in determining the properties of other isotopes of element 103, in particular of $^{257}103$, some additional experiments are needed. (auth)

**45046** PREPARATION AND CRYSTALLOGRAPHIC PROPERTIES OF CERTAIN LANTHANIDE AND ACTINIDE TRIBROMIDES AND TRIBROMIDE HEXAHYDRATES. Brown, D.; Fletcher, S.; Holah, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 8, 1889-94(1968).

Controlled vacuum thermal dehydration of lanthanide, actinide, and yttrium tribromide hexahydrates, $MBr_3 \cdot 6H_2O$ (M = Y, Pr, Nd, Gd–Lu incl., and U–Am incl.), gives the anhydrous tribromides. The tribromides of yttrium and of gadolinium to lutetium inclusive possess the rhombohedral ferric chloride type of structure, space group R3 ($C_{3i}^2$). The tribromide hexahydrates possess monoclinic symmetry, space group P2/n. Unit cell dimensions are reported for both series of compounds, and metal–bromine bond lengths were calculated for the tribromides with the assumption of a perfect octahedral arrangement. The positions of the metal–bromine stretching vibrations are reported for selected compounds. The results are discussed in relation to possible structural changes in the series of actinide trihalides, $MX_3$ (X = Cl, Br, or I). (auth) (UK)

**45047** THERMAL DECOMPOSITION OF URANYL(VI) OXALATE. Buttress, G. D.; Hughes, M. A. (Bradford Univ., Eng.). J. Chem. Soc., A, No. 8, 1985-9(1968).

The kinetics of thermal decomposition of uranyl(VI) oxalate were studied as a function of temperature in the range 300 to 350°C. In an inert atmosphere the reaction follows Prout–Tompkins kinetics, with an activation energy 62.4 ± 1.0 kcal/mole, and the final product is uranium dioxide. In the presence of air, the final product is amorphous trioxide, and the reaction is composed of two consecutive stages: (a) a reaction on the surface of the subgrain boundaries following Prout–Tompkins kinetics, and (b) a reaction involving isolated disc-like grains of reactant which follows an Avrami–Erofeev law with n = 2. The kinetic parameters for these stages are sensibly consistent with those found for the reaction in inert atmospheres. (auth) (UK)

**45048** SOME COMPLEX COMPOUNDS OF THORIUM(IV). Smith, B. C.; Wassef, Marguerite A. (London Univ.). J. Chem. Soc., A, No. 8, 1817-18(1968).

Thorium(IV) can undergo different types of reactions with solutions of electron-donors in organic solvents; these include complex formation, solvolysis, and salt formation. Complexes are formed with 1,10-phenanthroline, triphenylphosphine oxide, and diphenyl sulfoxide, but not with triphenylphosphine, triphenylphosphine sulfide, diphenyl sulfide, or diphenylsulfone. Solvolysis of thorium(IV) chloride and bromide by ethanol gives ethoxytrihalogenothorium(IV) complexes with 1,10-phenanthroline and triphenylphosphine oxide. Phenanthrolinium and phosphonium hexachloro- and nitrato-thorates(IV) are obtained from reactions in the presence of an excess of acid. (auth) (UK)

**45049** ELIMINATION REACTION WITH KINETICS CHARACTERISTIC OF THE ElcB MECHANISM. Crowell, Thomas I.; Kemp, Robert T.; Lutz, Robert E.; Wall, Arthur A. (Univ. of Virginia, Charlottesville). J. Amer. Chem. Soc., 90: 4638-43 (Aug. 14, 1968).

The dehydrochlorination of erythro-4,4′-dichlorochalcone dichloride, in absolute ethanol at 25°C, is subject to general base catalysis. The rate is a nonlinear function of the buffer concentration. The reaction is inhibited by acid. The trans-elimination product is predominantly formed from the erythro as well as from the more reactive threo substrate. A two-step mechanism, involving ionization followed by uncatalyzed cleavage of the carbanion, is consistent with the kinetics. Unless the carbanion is extremely short lived, however, some other explanation of the observed acid inhibition is required, since extensive deuterium exchange in the substrate does not take place. (auth)

**45050** RELATIVE RATES OF BASE-CATALYZED ENOLIZATION OF METHYL ALKYL KETONES IN AQUEOUS DIOXANE. Warkentin, J.; Barnett, C. (McMaster Univ., Hamilton, Ont.). J. Amer. Chem. Soc., 90: 4629-33(Aug. 14, 1968).

The effects of substituting methyl groups for hydrogen, at one methyl group of acetone and at $C_4$ of 2-butanone, on relative rates of hydroxide-catalyzed H–D exchange at $C_1$ and $C_3$, were determined by NMR. Rates were measured at 32°C, with solutions made from 2:1 dioxane–$D_2O$ (90 or 95 parts) and ketone (5 or 10 parts), all ratios referring to volumes. It was found that, for the α-substituted series beginning with acetone and ending with pinacolone as well as for the β-substituted series beginning with 2-butanone and ending with methyl neopentyl ketone, substitution reduces the rates of enolization of both reactive sites in a ketone. (auth)

**45051** MECHANISM OF ELECTRON TRANSFER OXIDATION OF ALKYL RADICALS BY COPPER(II) COMPLEXES. Kochi, J. K.; Bemis, A.; Jenkins, C. L. (Case Western Reserve Univ., Cleveland). J. Amer. Chem. Soc., 90: 4616-25(Aug. 14, 1968).

The rates of oxidation of n-butyl, isopropyl, and neopentyl radicals by carboxylatocopper(II) complexes were determined in acetonitrile–acetic acid solutions. The neopentyl radical was oxidized significantly slower than other alkyl radicals. Polar substituents had large effects on the relative rates of oxidative elimination and substitution of β-arylethyl radicals. Thus, the ratio of second-order rate constants $k_e/k_s$ for oxidative elimination and oxidative substitution for a series of substituted β-phenethyl radicals varies from 50 for m-methoxy, 33 for hydrogen, 1.3 for p-methyl to 0.014 for p-methoxy. The rate of oxidative substitution was enhanced by electron-releasing substituents, but oxidative elimination was retarded by these polar groups. The total rate of oxidation ($k_e/k_s$) of these β-arylethyl radicals, however, was remarkably constant. It was concluded that the rate-limiting step for oxidation of alkyl radicals by Cu(II) precedes and is separate from the product-determining step. An alkylcopper intermediate which is reversibly formed is postulated. Oxidative substitution results from heterolysis of this organocopper species to Cu(I) and a carbonium ion. (The β-arylethyl acetates isolated from the oxidation of β-phenethyl-β,β-$d_2$ and β-anisylethyl-α,α-$d_2$ radicals show complete equilibration of the α- and β-carbon atoms.) Oxidative elimination as a competing process also proceeds from the alkylcopper intermediate. Carbonium ions, as such, are not relevant to oxidative eliminations, since the styrenes which accompany the β-arylethyl acetates are not rearranged. The β-deuterium kinetic isotope effect in oxidative elimination of β-phenethyl radical is 2.8 to 2.9. It was concluded that electron transfer to Cu(II) has proceeded further than heterolysis of the β-proton in the transition state for oxidative elimination. (auth)

**45052** DECOMPOSITION OF VIBRATIONALLY EXCITED 1,1,1-TRIDEUTERIO-2,2-DIFLUOROETHANE. Perona, M. J.; Bryant, J. T.; Pritchard, G. O. (Univ. of California, Santa Barbara). J. Amer. Chem. Soc., 90: 4782-6(Aug. 28, 1968).

Evidence is presented that the vibrationally "hot" molecule $CF_2HCD_2^*$, formed by the combination of $CF_2H$ and $CD_3$ radicals, may decompose by three competing unimolecular processes to form $CFH=CD_2 + DF$, $CFD=CD_2 + HF$, and $CF_2=CD_2 + HD$. The second process, a three-center α,α elimination of HF from the same carbon atom, has not previously been observed. The evidence for the third process, HD elimination, is more tentative. An estimation of the Arrhenius parameters for the decompositions using classical Rice–Ramsperger–Kassel (RRK) theory is made, and the effect of collisional quenching of the "hot" molecules is discussed in terms of the critical energies for the eliminations. A similar experiment with $CFH_2CD_2^*$ showed no α,α elimination of HF. (auth)

**45053** MEASUREMENT OF SOLVENT ISOTOPE EFFECTS WITH THE GLASS ELECTRODE. PART II. THE DISSOCIATION CONSTANTS OF ACETIC AND BORIC ACID IN $D_2O$ AND $D_2O$–$H_2O$ MIXTURES. Gold, V.; Lowe, B. M. (King's Coll., London). J. Chem. Soc., A, No. 8, 1923-32(1968).

The dissociation constants were determined by means of a cell with glass and silver–silver chloride electrodes and without liquid junctions. The fractionation factor $\phi_1$ for isotopic exchange between solvent and undissociated acetic acid was determined from NMR measurements and is close to unity. The isotope effects, $\Delta pK_n = pK_n - pK_H$, are discussed in terms of the equilibrium theory of solvent isotope effects. For acetic acid $\Delta pK_n = 0.4630n + 0.0377n^2 + 0.0138n^3$ and for boric acid $\Delta pK_n = 0.399n + 0.131n^2 - 0.014n^3$. The possibility of distinguishing, from these measurements, between the structures $OB(OH)_2^-$ and $B(OH)_4^-$ is considered. (auth) (UK)

**45054** LINE SHAPE OF THE OD ABSORPTION IN THE INFRARED SPECTRUM OF PARTIALLY DEUTERATED WATER. Yellin, W.; Courchene, W. L. (Proctor and Gamble Co., Cincinnati). Nature (London), 219: 852-4(Aug. 24, 1968).

Attention is called to a remarkable change in band shape for the uncoupled OD oscillator of HDO in $H_2O$ on freezing. The infrared absorption of the OD band near 2,500 $cm^{-1}$ was measured in dilute solutions of $D_2O$ in $H_2O$ under conditions where the wings of the band could be observed for at least 250 $cm^{-1}$ on either side of the

absorption maximum. The OD band of ice is sharp and Lorentzian for at least 12 half-widths, and shows no asymmetry in this range. On melting, the band broadens and is Gaussian in shape for two half-widths. At 4°C no asymmetry is seen, but at higher temperatures asymmetry appears on the low frequency side of the band. Typical absorption spectra for HDO as displayed on a Calcomp plotter are shown. Results are discussed. It is emphasized that very dilute solutions of $D_2O$ in $H_2O$ were employed. The observed band envelopes were also subjected to moment analysis on a digital computer, and a plot is shown of the truncated second and third moments calculated from the digital data. The −7.6°C data follow the Lorentz profile, but the +4.1°C data exhibit properties similar to a Gaussian contour. The data are interpreted as indicating that the OD vibrations of HDO in dilute $D_2O$ solutions are uncoupled from internal vibrations of the HDO molecule and from intermolecular coupling to other HDO or $H_2O$ molecules. (UK)

**45055** THE ENCYCLOPEDIA OF THE CHEMICAL ELEMENTS. Hampel, Clifford A. (ed.). New York, Reinhold Book Corporation, 1968. 857p. $27.50.

Information is presented on the nature, properties, and behavior of each of the 103 elements. This includes the discovery and history of each element, its prevalence, sources, derivation, physical properties, chemical properties, the importance of the element and its compounds, applications of the element and its compounds, applications of the elements, and its biological and biochemical nature, including toxicological factors. A short reference list accompanies each article for supplemental reading. In addition to an article on each of the 103 elements, information is also included on related subjects. Among their titles are: Periodic Law and Periodic Table; Noble Gases; Lanthanide Elements; Transuranium Elements; Isotopes; Electronic Configuration; Origin of the Elements; and Prevalence of the Elements. A complete tabulation of the electrode potentials of the elements is also included. (P.C.H.)

**45056** COMPARATIVE STUDY OF THE ELECTROCRYSTALLIZATION OF TANTALUM AND NIOBIUM FROM MOLTEN FLUORIDE MIXTURES. Decroly, Cl.; Mukhtar, A.; Winand, R. (Free Univ. of Brussels). J. Electrochem. Soc., 115: 905-12 (Sept. 1968).

A comparison has been made of the electrocrystallization of tantalum and niobium from baths containing either KF and $K_2TaF_7$ or KF and $K_2NbF_7$. The main purpose was to determine why current efficiencies are generally much lower for niobium than for tantalum under the same experimental conditions. The phase diagram of the system $KF-K_2NbF_7$ has been drawn. Comparison with the diagrams of the system $KF-K_2TaF_7$ found in the literature did not give any evidence for a basic difference in the nature of the ionic species present in both types of baths. The results of the electrolyses performed led to the following main conclusions: An increase of the$K_2NbF_7$ or $K_2TaF_7$ content of the bath results in a considerable decrease of the current efficiency. This effect is much more striking for niobium than for tantalum. The grain size decreases also when the $K_2NbF_7$ or $K_2TaF_7$ content of the bath increases. The current efficiency increases roughly with the cathodic current density while the grain size shows a very complex behavior against the same parameter. The current efficiency decreases and the grain size increases when the length of the electrolysis increases. The grain size decreases regularly when the temperature increases, while the current efficiency passes through a maximum at about 900°C. Cathodic polarization curves lrawn in both types of bath have shown a rather complex behavior of the ionic species to be discharged at the cathode. It appears that some part of the metallic deposit at the cathode is removed from it by the agitation of the bath and by its own weight and is redissolved in the bath through a chemical reaction giving rise to lower valency species. A part of these species is reoxidized at the anode, and another part of them participates again in the cathodic process. This phenomenon is much more effective for niobium than for tantalum in the same type of bath. All the experimental observations were interpreted in terms of this mechanism. (auth)

**45057** KINETICS OF THE REDUCTION OF $U_4O_9$ WITH CARBON MONOXIDE. Shalaginov, V. N.; Vlasov, V. G.; Chazov, I. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Prikl. Khim., 41: 1397-1402(July 1968). (In Russian).

During study of the kinetics of the reduction of $U_4O_9$ with carbon monoxide in the temperature interval from 400 to 535°C and pressure of the gas reducer from 10 to 400 mm Hg, it was established that the dependence of the process velocity on the pressure of the carbon monoxide obeys the equation $\underline{v} = \underline{k}P^{\underline{n}}_{CO}$. The apparent activation energy does not depend on the degree of elimination of the oxygen and is equal to 32.2 ± 1 kcal/mole. On the basis of the kinetic and roentgenographic studies, the following phase conversion scheme was given: $U_4O_9 \rightarrow UO_{2+x_{max}} \rightarrow UO_{2+x}$. It was shown that in the process of the reduction of $U_4O_9$ to $UO_{2+x_{max}}$ two tendencies are evident, effective in mutually contradictory directions. The effect of these tendencies was compared and the character of the change of the variation of the reduction rate in relation to the oxygen elimination was determined. (tr-auth)

**45058** METHODS OF HEPTAVALENT NEPTUNIUM PRODUCTION. Spitsyn, I.; Krot, N. N.; Mefod'eva, M. P.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 181: 128-30(July-Aug. 1968). (In Russian).

An attempt was made to obtain Np(VII) by reactions of Np(VI) in alkali media with oxide compounds of hexa- and octavalent xenon, and with persulfate, periodate, and perborate ions, with sodium bismuthate and also with chlorine, bromine, and iodine. The experiments were carried out mainly with dilute neptunium(VI) solutions (~$2.5 \times 10^{-4}$ M). It was shown that it is possible to oxidize Np(VI) in alkaline media to the heptavalent state by ozone, persulfate, and periodate ions, xenon trioxide, perxenonate ions, sodium bismuthate, and hypochlorite and hypobromite ions. At pH 14, t = 25°C and activity of reagents equal to 1, the maximum and minimum redox potentials are 1.24 and 0.76 for $O_3/O_2$ and $BrO^-/Br$, respectively. It was found that Np(VII) may also be obtained by electrochemical oxidation of Np(VI) on a platinum anode. (R.V.J.)

**45059** SYNTHESIS AND METAL ION SELECTIVITY OF 4-VINYLPYRIDINE-ACRYLONITRILE OR ACRYLIC ACID-p-DIVINYLBENZENE-COPOLYMERS. Wolf, Friedrich; Hauptmann, Ruediger; Warnecke, Dieter (Univ., Halle, Ger.). Z. Anal. Chem., 238: 432-41(1968). (In German).

4-Vinylpyridine-acrylonitrile-p-divinylbenzene-terpolymers form complexes with Au and Ag ions (to a smaller extent also with Cu, Co, $UO_2$ and Ni ions) thus permitting the selective adsorption of these metals from their salt solution. (auth)

**45060** STUDIES ON INTERNAL WATER IN POROUS SILICAS. Cornier, G.; Baverez, M.; Bastick, J. (Ecole Nationale Superieure des Industries Chimiques, Nancy). Bull. Soc. Chim. Fr., No. 7, 2707-13(July 1968). (In French).

Changes in the number of inner hydroxyl groups were investigated while the samples were subjected to mechanical sintering under various pressures. These studies were carried out by infrared spectrometry and by isotopic exchange with $D_2O$. It is concluded that the internal hydroxyl groups essentially belong to silanol groups and are located in the contact areas between elementary silica particles. (auth)

**45061** INTERMEDIATES IN NUCLEOPHILIC AROMATIC SUBSTITUTION. I. TEMPERATURE-JUMP STUDY OF THE DECOMPOSITION OF 1,1-DIMETHOXY-2,4-DINITROCYCLOHEXADIENATE IN METHANOL. Bernasconi, Claude F. (Max-Planck Institut fuer Physikalische Chemie, Goettingen, Ger.). J. Amer. Chem. Soc., 90: 4982-8(Aug. 28, 1968).

The rate of decomposition of 1,1-dimethoxy-2,4-dinitrocyclohexadienate (I) into 2,4-dinitroanisole and methoxide ion was determined by applying the temperature-jump technique to concentrated solutions of 2,4-dinitroanisole and sodium methoxide in methanol and methanol-o-d. An appreciable discrepancy between the equilibrium constant for equilibrium 1 derived from kinetic data and a value reported in the literature is found and discussed. The effect of sodium methoxide concentration on the rates of formation and decomposition of complex I is to increase $k_1$ and decrease $k_{-1}$. The activation energy of 11.8 ± 0.5 kcal/mol is found to agree reasonably well with a value of 12.5 kcal/mol predicted by Miller. The present results are discussed with reference to other available kinetic and equilibrium data on related Meisenheimer complexes. The solvent deuterium isotope effect on the equilibrium is $K^H/K^D = 0.38 \pm 0.02$, on the rates is $k_{-1}^H/k_{-1}^D = 1.34 \pm 0.10$ and $k_1^H/k_1^D = 0.51 \pm 0.06$ at 25°C. It is interpreted as a secondary solvent isotope effect. Its significance with respect to the mechanism of general base catalyzed nucleophilic aromatic substitutions by amines is discussed. (auth)

**45062** MECHANISM OF HYDROLYSIS OF METHYL PSEUDO-2-BENZOYLBENZOATE IN AQUEOUS SULFURIC ACID. Weeks, Daniel P.; Grodski, Alex; Fanucci, Roy (Seton Hall Univ., South Orange, N. J.). J. Amer. Chem. Soc., 90: 4958-63(Aug. 28, 1968).

The hydrolysis of methyl pseudo-2-benzoylbenzoate in 1 M aqueous sulfuric acid is characterized by a $\Delta S^*$ of −19.4 eu and a $D_2O$ solvent isotope effect of $k_{H_2O}/k_{D_2O} = 0.50$. In 5 M sulfuric acid these values become −19.1 eu and 0.56, respectively. In moderately concentrated sulfuric acid a plot of log $k_\psi$ vs. $-H_0$ is linear with a slope of 0.67. A plot of log $k_\psi$ + $H_0$ vs. $H_0$ + log $[H^+]$ shows downward curvature. The slopes, $\phi$, are 0.66 at

1M and 0.41 at 5M. In 90% aqueous acetonitrile containing sulfuric acid (−)-methyl pseudo-(−)-2-benzoylbenzoate undergoes racemization much faster than hydrolysis. Thus, the evidence supports a mechanism which is bimolecular. (auth)

**45063** EFFECTS OF DEUTERIUM SUBSTITUTION ON THE ESR SPECTRUM OF THE BENZENE NEGATIVE ION. Lawler, Ronald G.; Fraenkel, George K. (Columbia Univ., New York). J. Chem. Phys., 49: 1126-39(Aug. 1, 1968).

An investigation was made of the effects of deuterium substitution on the electron spin resonance spectrum of the benzene negative ion. Spectra of the benzene-1-d, benzene-1,3-$d_2$, benzene-1,4-$d_2$, benzene-1,3,5-$d_3$, and benzene-$d_6$ anion radicals were obtained at −100° and −120°C, and a more extensive study of the temperature dependence of the spectrum of the benzene-1,4-$d_2$ anion was also carried out. The results for the benzene-1,3-$d_2$ and benzene-1,4-$d_2$ anions are in agreement with those reported previously for the benzene-1-d anion: The degeneracy of the benzene negative ion is removed by deuterium substitution. As expected, the degeneracy is not lifted in the benzene-1,3,5-$d_3$ and benzene-$d_6$ anions which have threefold or higher symmetry. The temperature dependence of the hyperfine splittings in those radicals which do not possess threefold or higher symmetry was found to be different from that of the unsubstituted benzene anion, and when compared to the benzene anion, some hyperfine splittings increase with temperature while others decrease. In addition, the proton−deuteron splitting-constant ratio was found to be approximately $(a_H/a_D) = 6.18$ in all of the radicals studied instead of the value $(a_H/a_D) = 6.514$ expected solely on the basis of the magnetic properties of the two isotopes. The effects of deuterium substitution are analyzed by assuming a rapid thermal equilibration between states corresponding to the symmetric and antisymmetric orbitals of the radicals, and estimates are made from the experimental data of the energy separations and relative populations of the two states. These depend on theoretical values for ...e spin densities; with a Hückel molecular orbital calculation they are −20, 22, and −38 $cm^{-1}$, respectively, for the benzene-1-d, benzene-1,3-$d_2$, benzene-1,4-$d_2$ anions. The spin densities and energy separations of the symmetric and antisymmetric forms have been calculated using the Hückel MO method without including vibronic interactions by using both a Coulomb and resonance-integral perturbation for the effects of deuterium substitution. (auth)

**45064** KINETIC ISOTOPE EFFECTS IN THE UNIMOLECULAR REACTIONS OF CHEMICALLY ACTIVATED CHLOROETHANE-$d_0$ AND -$d_5$ AND 1,2-DICHLOROETHANE-$d_0$ AND -$d_4$ MOLECULES. Dees, Kenneth; Setser, D. W. (Kansas State Univ., Manhattan). J. Chem. Phys., 49: 1193-1206(Aug. 1, 1968).

The nonequilibrium kinetic isotope effects for H−Cl and D−Cl elimination from chemically activated (average energy of ~91 kcal $mole^{-1}$) chloroethane-$d_0$ and -$d_5$ and 1,2-dichloroethane-$d_0$ and -$d_4$ were experimentally measured as 3.3 ± 0.4 and 3.5 ± 0.1, respectively. The chemically activated molecules were generated by the combination reactions of methyl and chloromethyl radicals or their deuterated equivalents at room temperature. These isotope effects and also some recently measured thermal activation isotope rate data were interpreted using RRKM computations based upon a four-centered model for the reaction. Rather good agreement between experimental results and the model calculations was obtained. Even all the kinetic data for chloroethane including the new isotope results were not sufficient to permit the definition of a unique model; however, both the thermal and chemical activation isotope measurements were best fitted by models with the hydrogen weakly bound in the four-centered ring. Suggestions are made for the relative contributions of the in-ring deuterium atom and of out-of-ring deuterium atoms to the overall nonequilibrium isotope effect for $C_2D_5Cl$. Calculated isotope effects are presented for chloroethane $d_1$, chloroethane-$d_4$, and some tritiated chloroethanes on the basis of the optimized models. (auth)

**45065** PHOTO-PHYSICOCHEMICAL BEHAVIOR OF IRON AND CHROMIUM COMPOUNDS. Suzuki, Shin; Matsumoto, Kazuo; Harada, Kieko; Tsubura, Eiko (Univ. of Chiba, Japan). Photogr. Sci. Eng., 12: 2-16(Jan.-Feb. 1968).

Some photo- and radiochemical reactions of chromic, chromate, and ferric ions exposed to visible, uv, and ionizing radiations were studied. When potassium dichromate or its solution was irradiated by γ rays from a $^{60}Co$ source, $Cr^{3+}$ was formed. In solutions acidified by sulfuric acid, the G-value was found to be 0.89 ± 1.19. When gelatin was present in the solution, the formation of $Cr^{3+}$ increased, and the G value increased to 2.72 ± 0.24. Gelatin itself may act as a reducing agent without irradiation, so a blank test was carried out and the net G value was determined to be 2.26 ± 1.29. This value was about 2.5 times larger than that without gelatin addition. The result is similar to that of the photochemical reaction. Although the energy is different between light and γ rays, some of the reaction mechanism in radiolysis may be analogous to the photochemical reaction. (BBB)

**45066** THERMAL DECOMPOSITION OF CURIUM(III) OXALATE 10-HYDRATE. Scherer, V.; Fochler, M. (Univ., Munich). J. Inorg. Nucl. Chem., 30: 1433-7(July 1968).

For a study of the thermal decomposition of curium oxalate a method was sought utilizing less than one mg of material. By continuously analyzing the gaseous reaction products with a mass spectrometer, a study of the thermal decomposition was made with ~100 μg of sample. Curium(III) oxalate hydrate may be dehydrated in vacuum at a temperature as low as 280°C, and decomposition of oxalate itself takes place with completion of the dehydration step. Carbon monoxide, formed initially during decomposition of the oxalate, is thought to undergo disproportionation into carbon and carbon dioxide, a process that occurs to the extent of nearly 60% in the first stages of decomposition. On gradually increasing the temperature, further decomposition takes place and various intermediates that appear to correspond to phases of definite composition are observed. These phases are contaminated with finely dispersed carbon. The compositions of all intermediate phases obtained in the temperature range 280 to 700°C are summarized. (auth)

**45067** STUDIES OF DIOXOURANIUM(V) IN DIMETHYLSULPHOXIDE. Gritzner, G.; Selbin, J. (Louisiana State Univ., Baton Rouge). J. Inorg. Nucl. Chem., 30: 1799-1804(Aug. 1968).

By carrying out controlled potential electrolysis on very dry dimethylsulphoxide solutions of $UO_2^{2+}$ nitrate under an argon atmosphere, sufficient quantities of $UO_2^+$ could be prepared for electronic spectral investigation. Disproportionation of this stable species into $UO_2^{2+}$ and $UO_2$ occurred, but the half-life of about 1 hr for $UO_2^+$ gave sufficient time for measurements to be made. In the region 6100 to 20,000 $cm^{-1}$ three maxima were observed. The main peak occurred at 6620 $cm^{-1}$ ($\epsilon \sim 87$) and the other two maxima of roughly one-tenth the intensity were observed at 12,940 $cm^{-1}$ and 15,080 $cm^{-1}$. The main peak is assignable as the $^2F_{\frac{5}{2}} \rightarrow {}^2F_{\frac{7}{2}}$ transition. (auth) (UK)

**45068** PREPARATION AND PROPERTIES OF THE VIOLET "$U_3O_8$ HYDRATE". Cordfunke, E. H. P.; Prins, G.; Van Vlaanderen, P. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem., 30: 1745-50(Aug. 1968).

The preparation of two non-stoichiometric $UO_3$ hydrates $UO_{2.86} \cdot 1.5\ H_2O$ and $UO_{2.88} \cdot 0.5\ H_2O$ is described. The so-called "$U_3O_8$ hydrate", described in the literature, is identical with the amorphous form of these non-stoichiometric $UO_3$ hydrates. The heats of formation and the water vapour pressures of these hydrates were measured. (auth) (UK)

**45069** ADSORPTION OF CATIONS FROM FORMIC ACID SOLUTIONS ON STRONG ACID CATION-EXCHANGE RESIN. SEPARATION OF ZIRCONIUM FROM THORIUM AND FROM GALLIUM. Qureshi, Mohsin; Husain, Waqif; Israili, A. H. (Aligarh Muslim Univ., India). Talanta, 15: 789-93(Aug. 1968).

The adsorption of Pb(II), Cu(II), Bi(III), Cd(II), Mn(II), Co(II), Ga(III), Y(III), Zr(IV), and Th(IV) from aqueous solutions of formic acid on cation-exchanger Dowex 50W-X8 was studied. Electrophoretic measurements were also made. Possible separations are suggested and discussed. Zirconium may be quantitatively separated from thorium and from gallium. (auth) (UK)

**45070** CARBON MONOXIDE ISOTOPE EXCHANGE WITH TANTALUM MONOCARBIDE. Gasser, R. P. H.; Gowan, P. M.; Newman, D. G. (Oxford Univ.). Trans. Faraday Soc., 64: 2196-9(Aug. 1968).

The isotope exchange reaction between $^{13}CO$ and a filament of $Ta^{12}C$ was studied at filament temperatures between 295 and 2,000°K. The reaction first became measurable at temperatures in excess of ca 1,000°K and was therefore associated with the more strongly bonded of the two states of carbon monoxide on tantalum monocarbide. The efficiency of exchange passed through a maximum of about 2.4% at a filament temperature of 1,600°K. Of the carbon monoxide desorbed after the filament had adsorbed at room temperature, the lower temperature α peak had not exchanged with the surface, whereas the higher temperature β peak had exchanged. (auth) (UK)

**45071** COMPLEX FLUORIDE COMPOUNDS IN BINARY AND TERNARY SYSTEMS. Nikolaev, N. S. (Moscow Inst. of General and Inorganic Chemistry). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 4, 3-12(Mar. 1968). (In Russian).

Systematic studies were made on HF−MeF−$H_2O$ systems (MeF are fluorides of alkali metals) by the isothermal solubility method in the whole range of HF concentration. A special study was also made of the fluorides of elements of the I to IV groups

of the periodic table and general rules of formation and complexing in the above systems. Solubility diagrams of the $H_2O-CaF_2-HF$, $H_2O-BaF_2-HF$, $H_2O-SrF_2-HF$, $HF-ZrO_2-H_2O$, $HF-Ta_2O_5-H_2O$, $HF-MoF_6-H_2O$, and $UO_3-HF-H_2O$ systems were developed. (R.V.J.)

**45072** SOME QUESTIONS ON THE THERMIC STABILITY AND REACTIVITY OF THE d AND f ELEMENTS HEXAFLUORIDES. Galkin, N. P.; Tumanov, Yu. N.; Butylkin, Yu. P. (Inst. of Inorganic Chemistry, Novosibirsk, USSR. Novosibirsk Inst. of Thermal Physics, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 4, 12-22(Mar. 1968). (In Russian).

Thermal stability and reactivity of hexafluorides of d and f elements were classified considering the constant bond between the elements and fluorides and thermodynamic stability of the $EF_6$ in relation to the $(EF_6)_g \rightarrow (EF_4)_g + 2\,(F)_g$. The regularities of the thermal stability of U, Np, Pu, Mo, and W hexafluorides were confirmed. Comparison of the thermal stability and reactivity of the hexafluorides were carried out by the analysis of the molecular constants, thermodynamic analysis using the quantum-statistical method, and by evaluating experimental data obtained. (R.V.J.)

**45073** ON SOME PROPERTIES OF URANIUM TRIOXIDE DIHYDRATE. Poko, Z.; Fodor, M.; Szabo, E. (Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung., 56: 357-60(1968).

Hydration products of different modifications of uranium trioxide were investigated. The thermal decomposition of the hydration products and the hydrolytic products in uranyl salt solutions were studied. The hydrated and hydrolyzed forms, as well as the products of their thermal decompositions, were analyzed by ir spectroscopy. It was established that the hydration or hydrolysis of amorphous and all crystalline $UO_3$ forms, except $\gamma$-$UO_3$, result in the same type of dihydrate with properties corresponding to the previously reported $\alpha$-variety. The $\beta$-$UO_3 \cdot 2H_2O$ was produced exclusively from $\gamma$-$UO_3$. Derivatograms were used in the study of thermal decomposition of both hydrates. (J.G.B.)

**45074** DERIVATOGRAPHIC INVESTIGATION OF THE DECOMPOSITION OF $U_3O_8$ IN AIR. Malinin, G. V.; Tolmachev, Yu. M. Radiokhimiya, 10: 362-6(1968). (In Russian).

At 870°C the endothermal decomposition of $U_3O_{8-x}$ into $U_3O_{21}$ began. The most probable value of the apparent activation energy of this process is 400 kcal/mole. With reduction of the temperature the oxidation of the reaction products occurs, which indicates the reversibility of this reaction. In the interval from 1050 to 1250° sintering of the uranium oxide samples studied occurred. It was shown that the activation energy calculated from the dependence of the peak of the curve of the weight variation with time on the annealing rate characterizes its process and does not depend on the form of the reaction vessel. The form of the decomposition curve depends on the form of the crucible. (tr-auth)

**45075** POLAROGRAPHIC STUDIES OF URANYL COMPLEXES WITH TRANS- AND CIS-BUTENEDIOIC ACIDS. Lai, Tsai-teh; Chen, Tsung-yu (Cheng Kung Univ., Tainan, China). Anal. Chim. Acta, 43: No. 1, 63-70(Oct. 1968).

The complexation of uranyl ion with fumaric and maleic acids was investigated by polarography and conductometry. The uranyl complexes of the two isomers differ: with fumaric acid, $UO_2(HFum)_2$ and $UO_2Fum_2^{2-}$ were observed whereas with maleic acid, only one chelate, $UO_2Mal_2^{2-}$, was obtained. The dissociation constants obtained from the half-wave potential vs. pH plots were $pK_1 = 3.05$ and $pK_2 = 4.55$ for fumaric acid and $pK_1 = 1.90$ and $pK_2 = 5.60$ for maleic acid. (auth)

**45076** URANIUM(IV) ACETATE AND ITS DOUBLE ACETATES WITH MAGNESIUM, IRON, AND ZINC. Grdenic, D.; Korpar-Colig, B. (Univ., Zagreb). J. Inorg. Nucl. Chem., 30: 1751-5 (Aug. 1968).

Uranyl(VI) acetate in glacial acetic acid was reduced with metallic magnesium, iron, zinc, or cadmium to uranium(IV) acetate or to the double acetates $MU(CH_3COO)_6$, M = Mg, Fe, and Zn, which are described for the first time. Cadmium did not form a double acetate, while the zinc double acetate easily lost zinc in acetic acid. The nonstoichiometry of zinc double acetate is explained by correlating its crystal structure with that of uranium (IV) acetate on the basis of the x-ray diffraction data, which are reported together with the ir spectra and the magnetic susceptibilities. The reduction of uranyl(VI) acetate with cadmium or zinc is recommended for the laboratory preparation of uranium (IV) acetate. (auth) (UK)

**45077** ON THE ACTIVITY OF GLASS AND THE METHOD OF ITS DEACTIVATION IN REACTIONS OF p-, o-CONVERSION AND ISOTOPIC EXCHANGE OF HYDROGEN. Peretyaka, A. R.; Danchevskaya, M. N. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 94-6(May-June 1968). (In Russian).

The catalytic activity of glass (3C-5, pyrex, silica tubes) was studied in the p-,o-conversion reactions and isotope exchange of hydrogen at 20 to 450°C. The activity increased sharply under the treatment with hydrogen and decreased under the influence of oxidants. The most stable deactivation of silica tubes was attained by treatment with oxygen at 800°C for two hours. The catalytic activity was supposed to be caused by SiOH-groups. (auth)

**45078** THERMAL CHARACTERISTICS OF CRYSTALLINE FRANCIUM HALOGENIDES AND ALKALI METAL ASTATIDES IN THE TEMPERATURE INTERVAL FROM 0 TO 300°K. Krestov, G. A.; Krestova, N. V. Radiokhimiya, 10: 344-50(1968). (In Russian).

The temperature coefficients of the interatomic distances and the linear coefficients of thermal expansion were calculated in the temperature interval from 0 to 300°K for FrF, FrCl, FrBr, FrI, NaAt, KAt, RbAt, CsAt, and FrAt. The regularities and their changes as a function of the temperature and nature of the salt studied were noted. Temperature coefficients of the ionic radii of $Fr^+$ and $At^-$ were examined in a wide temperature interval. (tr-auth)

**45079** THE SYSTEMS $KF-YF_3$, $BeF_2-YF_3$, $K_2BeF_4-K_3YF_6$. Borzenkova, M. P.; Novoselova, A. V.; Kuznetsova, G. N. (Moscow State Univ.). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 2, 5-9(Jan. 1968). (In Russian).

The $KF-YF_3$, $BeF_2-YF_3$, and $K_2BeF_4-K_3YF_6$ systems were investigated by thermographic and roentgenographic analysis. The position of the liquidus lines was made more precise by visual-polythermal methods. The presence in the $KF-YF_3$ system of the compounds $3KF \cdot YF_3$, $KF \cdot YF_3$, $KF \cdot 2YF_3$, $KF \cdot 3YF_3$, and $KF \cdot 6YF_3$ was confirmed. In the system $BeF_2-YF_3$ the position of the liquidus was found. The composition of the eutectic is ~79 mol % $BeF_2$ and $T_{fusion} = 800$°C. Indications were obtained on the glass formation in the system, complicating the study of the phase diagram of the system. It was shown that the system $K_2BeF_4-K_3YF_3$ is a quasibinary cross section of the ternary system of the fluorides of K, Be, and Y. (tr-auth)

**45080** MOLYBDENUM, TUNGSTEN, AND URANIUM OXYFLUORIDES OF ALKALI METALS AND AMMONIUM. Opalovskii, A. A.; Batsanov, S. S.; Kuznetsova, Z. M.; Nesterenko, M. N. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 2, 15-19(Jan. 1968). (In Russian).

Isothermal solubility in the system $MF-MeO_3-H_2O$ (M = $NH_4$, K, Rb, and Cs and Me = Mo, W, and U) was investigated with establishment of the composition of the solid phase by the Skreinemakers method. According to the data, the systems are developed by the method of synthesis of the molybdenum, tungsten, and uranium oxyfluorides of the molybdenum, tungsten, and uranium oxyfluorides of the alkali metals and ammonium. The synthesized compounds and the solid solutions were investigated by physical chemical methods. (tr-auth)

**45081** THERMOGRAPHIC INVESTIGATION OF BINARY SYSTEMS ON THE BASE OF ALKALI EARTH AND RARE EARTH FLUORIDES. Zagorskaya, Z. A.; Ivanova, I. A.; Maksakov, B. I. (State Optical Inst., Leningrad). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 2, 27-30(Jan. 1968). (In Russian).

The fusion diagrams of the systems $CaF_2-YF_3$, $CaF_2-YbF_3$, $CaF_2-CeF_3$, and $CaF_2-LaF_3$ were investigated. It was found that these systems form two forms of the fusion diagram with four compounds in the $CaF_2-LaF_3$ and $CaF_2-CeF_3$ systems and two compounds in the $CaF_2-YF_3$ and $CaF_2-YbF_3$ systems. Comparison of the data from the roentgenographic and thermographic analysis showed that in these systems there exist ranges of solid solutions. (tr-auth)

**45082** X-RAY STRUCTURE INVESTIGATION OF $UF_4.2.5H_2O$ AND ITS DEHYDRATION PRODUCTS. Zadneprovskii, G. M.; Polishchuk, S. A.; Borisov, S. V.; Gagarinskii, Yu. V. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 2, 122-6(Jan. 1968). (In Russian).

An x-ray structure investigation was made of the rhombic form of the uranium tetrafluoride hydrate $UF_4 \cdot 2.5H_2O$ and its dehydration products. The coordinates of the U atoms were determined. In the original crystal hydrate $UF_4 \cdot 2.5H_2O$, the uranium occupies two individual tetramultiple positions in the mirror planes and forms bands orientated along the c axis. X-ray amorphous products, formed during the dehydration of the rhombic $UF_4 \cdot 2.5H_2O$, differ with respect to structure both from the original crystal

hydrate and from $UF_4$, and probably represents a disperse phase formed during the dehydration of $UF_4 \cdot 4/3H_2O$. (tr-auth)

**45083** X-RAY INVESTIGATION OF URANYL FLUORIDES OF RUBIDIUM AND CESIUM AND THE QUESTIONS OF AUTOMATION OF THE INDICATION OF X-RAY PATTERNS. Rebenko, A. N.; Brusentsev, F. A.; Opalovskii, A. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 2, 136-8(Jan. 1968). (In Russian).

An x-ray structure investigation of some rubidium and cesium uranyl fluorides was carried out: $Cs_3UO_2F_5$, $Cs_4(UO_2)_5(OH)_6F_8 \cdot 8H_2O$, $RbUO_2(OH)_2F \cdot 1.5H_2O$, and $Rb_5(UO_2)_2(OH)_4F_5 \cdot 1.5H_2O$. The experiments were carried out on the diffractometer URS-50IM. The data processing was done by means of a computer program devised for EVM. (tr-auth)

**45084** THERMAL DEHYDRATION OF URANYL NITRATE HYDRATES. Smith, Warren H. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Inorg. Nucl. Chem., 30: 1761-8(Aug. 1968). (MLM-1498J).

Differential thermal analysis and thermogravimetric analysis were used to determine the steps of the thermal dehydration of uranyl nitrate hexahydrate, trihydrate, and dihydrate. The results indicate that there were no apparent differences in the dehydration when the experiments were performed in dry nitrogen or in dry air. Enthalpy values are reported for the transitions involved. (auth) (UK)

**45085** INTERACTION OF TANTALUM PENTAOXIDE WITH HYDROGEN AND WITH CARBON MONOXIDE. Dneprova, V. G.; Rezukhina, T. N.; Gerasimov, Ya. I. (Moscow State Univ.). Zh. Fiz. Khim., 42: 1530-2(June 1968). (In Russian).

The possibility of the reduction of $Ta_2O_5$ with hydrogen and carbon monoxide at 1100° and with prolonged contact of the reagents under conditions of continuous freezing of the $H_2O$ or $CO_2$ by liquid nitrogen was investigated. The reduction product of $Ta_2O_5$ with hydrogen has the composition $Ta_2O_{4.66}$. No other phase, such as the low-temperature modification of $Ta_2O_5$, was detected by x-ray analysis. During interaction with CO a carbide with the composition $TaC_{0.8}$ and free carbon were formed in small quanity. The formation of the carbide proceeds by the reaction $Ta_2O_5 + 8.2\ CO \rightarrow 6.6\ CO_2 + 2TaC_{0.8}$. (tr-auth)

**45086** STUDIES OF REACTIONS OF URANYL FLUORIDE AND RUBIDIUM FLUORIDE IN AQUEOUS SOLUTIONS. Davidovich, R. L.; Sergienko, V. I.; Kalacheva, T. A. (Academy of Sciences, Novosibirsk, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 8, 1678-84(Aug. 1968). (In Russian).

Reactions of uranyl fluoride and rubidium fluoride were studied and the $RbF-UO_2F_2-H_2O$ system was analyzed in molar ratio from 1:1 to 20:1. Chemical, x-ray, ir spectrographic, and thermogravimetric analyses were made of the synthesis of the previously unknown complex compounds $Rb_2(UO_2)_3F_8 \cdot 4H_2O$, $Rb_2UO_2F_4 \cdot H_2O$, and $Rb_3UO_2F_5$. The aqueous bond in the synthesized uranyl fluoride crystal hydrates with rubidium was also determined. (R.V.J.)

**45087** THE KINETIC ISOTOPE EFFECT IN REACTIONS OF PROTOPHILIC ISOTOPE EXCHANGE OF HYDROGEN OF CH-ACIDS WITH DIMETHYL SULPHOXIDE. Shapiro, I. O.; Yakushin, F. S.; Romanskii, I. A.; Shatenshtein, A. I. (Inst. of Physical Chemistry, Moscow). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ., 5: No. 1, 168-78(Mar. 1968). (In Russian).

The results of the investigation of the kinetic isotopic effect (KIE) in the reactions of the protophilic isotopic exchange of the hydrogen of several CH-acids (diphenyl methane, thiophene, furan, toluene, thioanisole, and diphenyl ether) with dimethyl sulfoxide catalyzed by potassium or lithium t-butylates are reported. The KIE for these reactions was found to be lower ($A\ k_D/k_T = 1.1 - 1.5$) as one can expect from the theoretical viewpoint ($k_D/k_T = 2.55$ at 25°) as well as the experimental values for the same reaction in liquid ammonia and in cyclohexyl amine. The data are discussed in connection with the problem of the differentiating influence of the solvents upon the kinetic acidity of carboacids. Analysis of the existing experimental data for KIE in ionization reactions as well as for isomerisations and protophilic isotope exchange for carboacids led to the conclusion that for the last reaction there exists specific pecularities of the mechanism in the system consisted from DMSO and alkaline t-butylate. (auth)

**45088** THERMODYNAMIC PROPERTIES OF THE HIGHER OXIDES OF TANTALUM. Dneprova, V. G.; Rezukhina, T. N.; Gerasimov, Ya. I. (Moscow State Univ.). Zh. Fiz. Khim., 42: 1532-5(June 1968). (In Russian).

From the emf of the galvanic element $Pt|Ta_2O_{5-x}|0.85ThO_2 \cdot 0.15LaO_{1.5}|Fe, Fe_{0.95}O|Pt$, at 1432°K, the partial Gibbs energies for the reaction $1/\delta\ Ta_2O_{5-x} \rightarrow 1/\delta\ Ta_2O_{5-x-\delta} + 1/2\ O_2$ and oxygen pressures over the tantalum oxides in the composition interval from $Ta_2O_5$ to $TaO_2$ were calculated. In the case of $Ta_2O_{5-x}$ ($x < 0.002$), which is very close to stoichiometry, $\Delta G_T°[cal] = 61700 - 14\ T$ was obtained in the temperature interval from 1330 to 1438°K. The coulometric titration method was used for the variation of the composition of the electrode studies ($Ta_2O_{5-x}$). (tr-auth)

**45089** CRYSTALLINE AMERICIUM TRIHYDROXIDE. Milligan, W. O. (Baylor Univ., Waco, Tex.); Beasley, M. L.; Lloyd, M. H.; Haire, R. G. Acta Crystallogr., Sect. B, 24: 979-80(1968).

Aging of amorphous precipitated hydrous americia gel under water yields rod-like or scroll-like particles of hexagonal Am $(OH)_3$ ($a = 6.426 \pm 0.002$, $c = 3.745 \pm 0.002$ Å) isostructural with $Nd(OH)_3$ ($a = 6.422 \pm 0.002$, $c = 3.742 \pm 0.002$ Å). (auth) (Denmark)

**45090** KHIMIYA TRANSURANOVYKH I OSKOLOCHNYKH ELEMENTOV. (Chemistry of Transuranium Elements and Fission Products). Vdovenko, V. M. (ed.). Leningrad, Izdatel'stvo Nauka Leningradskoe Otdelenie, 1967. 184p.

Thirty-four articles are included on complex compounds of U, Np, Am, Cm, and rare earths in various media. Nine articles cover the kinetics of U(IV) oxidation in $HNO_3$, solubility of complex sodium uranyltriacetate, solubility of the n-butyl ester of di-n-butylphosphinic acid in aqueous uranyl nitrate and $HNO_3$ solutions, kinetics of $UO_3$ solution in $H_2SO_4$, and spectrophotometric studies of uranyl triacetate hydrolysis. Mixed complex uranyl compounds, infrared spectra and structure of tri- and tetraalkyl ammonium with trihalide acetates and uranyl trihalide acetates, chemical states of $^{239}U$ and $^{239}Np$ in neutron-irradiated uranyl salts, precipitation of Np on metals and oxalate compounds of Np(IV) are studied in the following seven articles. Extraction of Pu(IV) and other elements by Arsenazo III, complexing of Am (III), Cm(III), and Ce(III) with nitrilotriacetic acid by electromigration, Am, Cm, and rare earth distribution in $LiNO_3-AB-17$, redox reaction of actinide elements, Np(IV) reaction with Fe(III) and Np(V) with Fe(II) are covered in the next eight articles. The last eight articles include data on complexing of trivalent actinides and lanthanides with $\alpha$-oxyisobutyric acid, stability of complex actinide compounds and Ce(IV), sorption of transuranium and rare earth elements from high-acidity $HNO_3$ and $HClO_4$ solutions on cations, determination of microquantities of Rb, Sr, and Y, and a rapid method for production concentrated solutions of Fr. (R.V.J.)

## Radiation and Nuclear Chemistry

*Refer also to abstracts 45029 and 46920.*

**45091** (BMwF-FBK-68-09) CALCULATIONS FOR THE PREPARATION OF $^{232}U$ BY NEUTRON IRRADIATION OF A $^{230}Th-^{232}Th$ MIXTURE IN THE REACTOR. Kim, J. I.; Flakus, F. N. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Mar. 1968. 19p. (In German). Dep.

Calculations are made for the production of the isotope uranium-232 by reactor neutron irradiation of a thorium-ionium mixture. Special consideration is given to one special irradiation position of the FRM reactor. Effects of the neutron spectrum on the production of uranium-232 are considered. Following the results of calculations, a preliminary production scheme was prepared, and proper irradiation conditions are discussed. (auth)

**45092** (COO-584-37) TECHNICAL PROGRESS REPORT [ON IRRADIATION OF METHANE WITH ELECTRONS IN THE 9-50 e.v. RANGE], NOVEMBER 15, 1967-NOVEMBER 14, 1968. (Kansas State Univ., Manhattan). Contract AT(11-1)-584. 17p. Dep. CFSTI.

Methane at pressures of 0.010 to 0.025 torr was irradiated with electrons possessing kinetic energies in the 9 to 50 eV range. The reactivity of electrons with energies less than the ionization energy was found to be extremely small. At 12 eV the cross section for formation of $C_2H_4$ and $C_2H_6$, the principal hydrocarbon products, was found to be less than $3.4 \times 10^{-18}$ cm$^2$. At 13.0 eV the cross section was $1.51 \times 10^{-17}$ cm$^2$, and above this energy the cross section continued to rise sharply. The effect of energy on electron reactivity suggests that the role of subionization energy electrons in radiation chemistry may be minimal. (auth)

**45093** (COO-1618-9) ON THE CATION EFFECT ON THE DISTRIBUTION OF OXIDATION STATES FOLLOWING RADIATIVE-NEUTRON CAPTURE REACTIONS ON AN ANIONIC SPECIES. Anselmo, Vincent C. (New Mexico Highlands Univ., Las Vegas. Dept. of Chemistry). Aug. 13, 1968. Contract AT(11-1)-1618. 5p. Dep. CFSTI.

Calculations were performed on the influence of the nuclear reactions of the cation on the oxidation states observed following radiative-neutron capture on a particular salt where the anionic

species is under scrutiny. Any radiation damage from photons evolved because of the exoergicity of the reaction, or from nuclear decay reactions, including also beta decay, are negligible and should not cause any radiation effect, at least for the irradiation condition described. (auth)

**45094** (LFEN-78) STUDY OF THE CHEMICAL EFFECT OF THE REACTION (n,γ) IN CRYSTALS OF IRRIDIUM HEXACHLORIDE(IV). Peixoto Cabral, J. M. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1967. 81p. (In Portuguese). Dep.

Electrophoreses carried out with aqueous solutions of $Na_2IrCl_6 \cdot 6H_2O$ showed that the $IrCl_6^{2-}$ is transformed into $IrCl_6^{3-}$ during the electrophoresis. Gamma irradiation of fresh $Na_2IrCl_6 \cdot 2H_2O$ solutions in 0.01N HCl showed that the $IrCl_6^{3-}$ is oxidized to $IrCl_6^{2-}$. The amount of $IrCl_6^{3-}$ obtained depended on the radiation dose. The electrophoretic behavior of some chloro-aquocomplexes of iridium(IV), using oxidized solutions of the corresponding iridium (III) complexes in 0.01N HCl, was studied. Electrophoreses carried out with solutions of neutron-irradiated $Na_2IrCl_6 \cdot 6H_2O$ crystals, under the same experimental conditions as those adopted in previous experiments, showed that most of the $^{192}Ir$ recoil atoms are present in the III valence state, mainly as complexes belonging to the series $Ir(H_2O)_n Cl_m^{3-m}$ ($n + m = 6$; $1 \leq m \leq 5$). Some dinuclear complexes were also found, which were transformed into the latter ones after a few days. A small percentage of iridium(IV) species could be detected, as well as a very small percentage of other species that could not be identified and are possibly isomers of some of the known species. Electrophoreses carried out with solutions of neutron-irradiated $(NH_4)_2IrCl_6$ crystals showed that these solutions contain all the $^{192}Ir$ species found in identical solutions of neutron-irradiated $Na_2IrCl_6 \cdot 6H_2O$ crystals. Three further species were found, which could not be detected either in solutions of neutron-irradiated $Na_2IrCl_6 \cdot 6H_2O$ or $K_2IrCl_6$ crystals. These results suggest that such species may be formed in the crystals, by means of reactions between the recoil fragments and species derived from the ammonium ion. Electrophoreses carried out with solutions of neutron-irradiated $K_2IrCl_6$ crystals showed that all the $^{192}Ir$ species present in these solutions are iridium complexes that also exist in equivalent solutions of neutron-irradiated $Na_2IrCl_6 \cdot 6H_2O$ crystals. The percentages of these species are, however, quite different in the two cases. While in hydrated sodium salt solutions the predominant recoil species are iridium(III) complexes, in fresh solutions of anhydrous potassium salt they are iridium(IV) complexes. These products were identified as being $Ir(H_2O)_2Cl_4$, or a polymer derived from this, and $Ir(OH)Cl_5^{2-}$. In solutions of pH 7 all the $Ir(H_2O_2)_2Cl_4$ is dissociated into $Ir(OH)_2Cl_4^{-}$. By comparing the results obtained with the hydrated crystals with those obtained with the anhydrous crystals it was concluded that some reduction reactions occur in the $Na_2IrCl_6 \cdot 6H_2O$ crystals between the recoil fragments and water molecules or species derived from this water. It is also concluded that the presence of water molecules in the crystals inhibits recombination reactions between the recoil fragments and $Cl^-$ ions, which are also produced as a consequence of the recoil. A comparison of the results obtained with the $(NH_4)_2IrCl_6$ and $K_2IrCl_6$ crystals, which are both anhydrous, indicates that some reduction reactions also occur in the $(NH_4)_2IrCl_6$ crystals between the recoil fragments and species derived from the ammonium ion. (auth)

**45095** (RLO-2043-2) THE GRAFTING OF ORGANIC POLYMERS ONTO INORGANIC SUBSTANCES. Final Report. Raff, R. A. V. (Washington State Univ., Pullman. Research Div.). Jan. 30, 1968. Contract AT(45-1)-2043. 109p. Dep. CFSTI.

Work reported in the literature on the grafting of organic polymers onto inorganic substances is reviewed. Topics treated are: adhesion of polymers to inorganic substrates; glass fiber reinforced laminates; grafting on glass fiber treated with titanium tetrachloride; adsorption of polymers on inorganic substances; pretreatment of clay surfaces; catalyzed polymerization of gaseous monomers at a liquid–gas interface; polymerization on freshly formed inorganic surfaces; polymer formation on electric contacts and on sliding metals; polymer grafting on carbon blacks; radiation polymerization on inorganic substances; polymer grafting on inorganic substances in polymer processing; biological significance of polymer grafting on inorganics; techniques of graft characterization; and, summary and conclusions. (245 references) (J.G.B.)

**45096** ESR STUDIES ON THE RADICAL STRUCTURE IN IRRADIATED L-LEUCINE HYDROCHLORIDE. Lassmann, G.; Damerau, W. (Inst. of Biophysics, Berlin). Biophysik, 5: 14-23(1968). (In German).

The structure of radicals in x-irradiated polycrystalline L-leucine · HCl was studied by ESR. At room temperature the radical $(CH_3)_2 > \dot{C} - CH_2 - CHNH_3^+ - COOH$ is formed by abstraction of the > C–H-proton. The isotropic part of hyperfine interaction with eight β-protons was measured even in polycrystalline state with following values: at 300°K $a_{CH_3} = 23.5 \pm 1$ gauss for six equivalent $CH_3$-protons and $a^{(1)}_{CH_2} = 8.0 \pm 1$ gauss and $a^{(2)}_{CH_2} = 38.8 \pm 1$ gauss for two $CH_2$-protons, at 77°K $a_{CH_3} = 22.6 \pm 1$ gauss, $a^{(1)}_{CH_2} = 8.8 \pm 1$ gauss and $a^{(2)}_{CH_2} = 45.2 \pm 1$ gauss respectively (the coupling of the $CH_2$-protons is dependent on temperature). This radical is present already following irradiation at 77°K. (auth)

**45097** INVESTIGATIONS ON THE CHEMICAL NATURE OF BIOLOGICAL RADIATION DAMAGES. Fahr, E. (Univ., Wuerzburg, Ger.). Biophysik, 5: 2-13(1968). (In German).

When aqueous solutions of uracil, uridine, and uridylic acids or cytosine, cytidine, and cytidylic acid are irradiated by uv, 6-hydroxydihydrouracil or 6-hydroxydihydrocytosine derivatives are formed by addition of water to the C = C-bond; the structures of these compounds are proven by synthesis. On standing the 6-hydroxydihydrocytosine derivatives are deaminated yielding 6-hydroxydihydrouracil. This means that the cytosine part of DNS can be transformed to an uracil derivative by addition of water and following deamination. These two reaction steps which are chemically proven may explain the mutations effected by uv irradiation. The dimeric uracil was synthesized chemically. The behavior of dimeric uracils is discussed. The reactions started by ionizing irradiation of nucleic acids are discussed. The irradiation products obtained derived mainly from the addition of H- and OH-radicals to the C = C-bond of the pyrimidine system. The products formed by adding water to the irradiation products are the same as for uv. This means that for the understanding of the mutations originated by ionizing irradiation a transformation of the cytosine part of DNS into a uracil derivative can be considered. (auth)

**45098** SOME EFFECTS OF IONIZING RADIATION ON A POLYHYDROXYETHER. Golden, J. H.; Hammant, B. L.; Hazell, E. A. (Explosives Research and Development Establishment, Waltham Abbey, Eng.). J. Appl. Polym. Sci., 12: 1807-13(Aug. 1968).

The behavior of the polyhydroxyether derived from bisphenol A and epichlorohydrin on exposure to electron irradiation (0 to 500 MRADS) in vacuum was investigated. The polymer underwent chain scission, G = 0.20 (scission per 100 eV), with no evidence of crosslinking. Degradation was accompanied by the loss of $H_2$ together with smaller quantities of CO, $CO_2$, and $CH_4$. Spectroscopic studies are reported, and a mechanism of degradation is proposed. The tensile yield stress and fracture energy of molded specimens were also examined, and changes in these properties as functions of radiation dose and molecular weight are discussed. (auth)

**45099** ECONOMIC PERSPECTIVES OF A CHEMICAL-NUCLEAR COMPLEX FOR THE PRODUCTION OF NITROGEN COMPOUNDS. Bendell, M. Energ. Nucl. (Paris), 10: 231-5 (May 1968). (In French).

The production of hydrazine and nitrogen dioxide within nuclear reactors has been investigated in some detail by many workers. The primary problems in the industrial realization of this technique are the technical difficulties in the development of the chemico-nuclear process, the decontamination of the product fabricated, and the production costs. Each of these is discussed and data on these problems are tabulated. The electrochemical-nuclear production of ammonia is also discussed. (J.S.R.)

**45100** CHEMICAL TRANSFORMATIONS OF POTASSIUM CYANIDE INDUCED BY NUCLEAR $^{14}N(n,p)^{14}C$ REACTION. RADIOLYTICAL DECOMPOSITION OF THE TARGET DURING IRRADIATION. Kuhry, Jean-Georges; Adloff, Jean-Pierre (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. Fr., No. 6, 2402(June 1968). (In French).

Neutron irradiation of KCN led to the following $^{14}C$-labeled products: cyanide (44%), elementary carbon (36%), cyanamide (13%) and acetylene(8%). The target was radiolysed mainly into cyanamide and carbon. (auth)

**45101** INFLUENCE OF VARIOUS GLYCERINE CONCENTRACTIONS ON THE YIELDS IN AN IRON(II) SULFATE DOSIMETER (FRICKE DOSIMETER). Lamprecht, Ingolf; Umlauf, Christa; Stein, Werner (Freie Univ., Berlin). Z. Naturforsch., 23b: 320-5(Mar. 1968). (In German).

The oxidation of ferrous to ferric iron was used as a measure of the effect of ionising radiation in Fricke dosimeter solution in the presence of glycerine at various concentrations. At low glycerine concentrations the sensitivity of the system to x rays was found to be increased by the presence of the alcohol while at higher concentrations a radiation-protection effect was observed. The increased sensitivity rose to a maximum at glycerine concentrations of 0.01 to 0.1 M, the size of the maximum depending on the duration of the

radiation. The peak represents a sensitivity of about twice the normal ion conversion. The falling off at low concentrations is explained on the basis of a model where the presence of alcohol leads directly to increased ferric ion yield, that at high concentrations as being due to increased viscosity of the system. Other alcohols showed similar results. (auth)

**45102** DYNAMIC-MECHANICAL STUDIES ON RADIATION-CROSSLINKED POLY(VINYL CHLORIDE). Posselt, K. (Institut fuer Metallphysik und Reinstmetalle, Dresden). Kolloid Zh., 223: 104-10(Apr. 1968). (In German).

Mixtures of poly(vinyl chloride) (PVC) and triallyl cyanurate (TAC) were exposed to $^{60}$Co $\gamma$ radiation and thereby crosslinked. These mixtures were studied by measurements of the complex shear modulus in dependence of the temperature before and after the irradiation. While the monomer TAC in the mixtures before the irradiations acted as a plasticizer and therefore yielded the typical plasticizer effect in the relaxation spectrum, irradiation caused crosslinking of the material and a shifting of the softening range to higher temperatures. Such radiation effects were not found with mixtures of PVP with other monomers from which it was concluded that the deciding factor for the improvement of crosslinking ability is not the increase of the molecular mobility due to plasticizing efficiency of the TAC but the polyfunctionality of the monomer mixture. From the results obtained the average molecular kinetic activation parameters are estimated, showing the influence of plasticizing and crosslinking to these parameters. (BBB)

**45103** PRODUCTION OF CARRIER-FREE $^{131m}$Xe BY USING AN ADSORPTION METHOD. Bedrossian, P.; Toth, G.; Zsinka, L. Isotopenpraxis, 4: 117-18(Mar. 1968). (In German).

The $\beta$ transformation of $^{131}$I, of which 0.7% leads to $^{131m}$Xe, serves as a possibility for production of a pure radioactive xenon isotope. An absorption method was developed for milking the $^{131m}$Xe. The method gave a product that was 80 to 95% $^{131m}$Xe. (M.C.G.)

**45104** RADIATION RESISTANCE OF PLASTICS. III. SHORT TERM IRRADIATION TESTS OF PVC PIPES. Wilski, H.; Gaube, E. (Farbwerke Hoechst AG, Frankfurt am Main). Kerntechnik, 10: 384-7(July 1968). (In German and English).

Poly(vinyl chloride) pipes were gamma-irradiated in air at an absorbed dose rate of 0.19 MRad/hr using a $^{60}$Co source. Despite the considerable cross-linking caused by irradiation, the bursting time in the creep rupture test under internal pressure according to DIN 8061 deteriorated instead of improving. The maximum permissible dose for PVC 100 pipes possessing the high reserve strength commonly obtainable at present, was found to be 6 to 10 MRad. If the same pipes are used at stresses not exceeding 60 kgf/cm$^2$, the maximum permissible dose would seem to be 15 to 20 MRad. Impact strength tests conducted at 20 and at 60°C according to DIN 8061 showed that a transition from tough to brittle behavior occurs at doses between 15 and 20 MRad. (auth)

**45105** CHEMICAL STATE OF RADIOSULPHUR IN NEUTRON-IRRADIATED SODIUM CHLORIDE AND POTASSIUM CHLORIDE. Chiotan, C.; Szabo, Maria; Zamfir, Ioana; Costea, T. (Inst. of Atomic Physics, Bucharest). J. Inorg. Nucl. Chem., 30: 1377-88 (July 1968).

Neutron-irradiated samples of NaCl and KCl were heated isothermally at temperatures between 150 and 725°C. The results showed that the reduced radiosulfur fraction R ($S^{2-} + S^0$) increases with the temperature and the time of heating. Phenomenological and kinetic evidence is presented for the existence of two annealing processes, for which the activation energies and reaction orders were determined. At T < 350°C, a first order process takes place, possibly associated with the annealing of radiation damage. This leads to an increase of R as a result of the reduction in the oxidized sulfur fractions. At T > 350°C a second process is observed, evidenced by an increase in the elementary sulfur fraction ($S^0$) at the expense of $S^{2-}$ and oxidized sulfur fractions. The mechanism proposed leads to the suggestion that the species $S^+$, $S^0$ and $S^-$ exist in the crystals. (auth) (UK)

**45106** ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF DEOXYADENOSINE MONOHYDRATE. Lichter, James J.; Gordy, Walter (Duke Univ., Durham, N. C.). Proc. Nat. Acad. Sci. U. S., 60: 450-5(June 15, 1968).

ESR studies of H-addition radicals in gamma-irradiated single crystals of deoxyadenosine monohydrate indicated that H-addition occurs on $C_{(2)}$ rather than on $C_{(8)}$. The resulting unpaired electron has spin densities of 0.17 on $N_{(1)}$ and 0.37 on $N_{(3)}$. (M.C.G.)

**45107** LUMINESCENCE OF ELECTRON-IRRADIATED CdS. Fujino, Takahiro; Yoshida, Toshio; Kitagawa, Michiharu; Oka, Takashi. Annu. Rep. Radiat. Center Osaka Prefect., 8: 82-4 (1967).

The effects of 5-MeV electrons on the luminescence of CdS were investigated. Irradiation was carried out at temperatures near liquid nitrogen temperature. The blue emission band at 488 m$\mu$ and the green edge emission band around 512 m$\mu$ did not change in structure but decreased in intensity. A remarkable recovery of both bands was found during annealing at dry ice temperature. Irradiation with 5-MeV electrons may effectively produce defects that reduce the emission efficiency of both bands and are not stable even at dry ice temperature. (auth)

**45108** PARAMAGNETIC DEFECTS ASSOCIATED WITH HYDROGEN ADSORBED ON THE SURFACE OF MAGNESIUM AND CALCIUM OXIDES. Tench, A. J.; Nelson, R. L. (Atomic Energy Research Establishment, Harwell, Eng.). J. Colloid Interface Sci., 26: 364-73(Mar. 1968).

Surface defects produced when CaO and MgO with adsorbed $H_2$ or $D_2$ were irradiated ($^{60}$Co, spent fuel, or uv light) are described. Irradiation of MgO and CaO in the form of small particles (100 to 300 Å) led to the formation of surface paramagnetic centers (S centers) which reacted with oxygen. Both S centers and new surface centers (Su centers) with G = 1.9998 were formed if the oxides were $\gamma$ irradiated in the presence of $H_2$ and $D_2$. The $S_H$ center showed a hyperfine coupling from 1 H nucleus, and both the S and $S_H$ centers showed a hyperfine interaction with the Mg nuclei of the lattice to give splitting constants of 25.5 and 10.2 G, respectively. These surface centers are believed to be intrinsic defects consisting of an electron trapped at a surface anion vacancy and provide a surface equivalent of the well-known bulk defects (F centers). The nearby proton in the $S_H$ center suggests that the H must react with surface O ions during irradiation. (BBB)

**45109** ENERGY-INDUCED CHANGES IN AN AZO DYESTUFF WASTE. Mytelka, Alan Ira. New Brunswick, N. J., Rutgers-The State Univ., 1967. 107p.

Thesis.

The energy-induced chemical and physical changes in an azo dyestuff mother liquor and the relationship of these energy induced-changes to biological treatment were studied using chemical oxidizing agents and ionizing radiation from $^{60}$Co $\gamma$ rays. The azo dyestuff mother liquor contained 9.4% solids of which 2.5% were volatile and the rest fixed. The chemical oxygen demand (COD) was 49,000 mg $O_2$/l, the total organic carbon (TOC) was 15,000 mg C/l and the biochemical oxygen demand ($BOD_5^{20}$), calculated from a dilution of 3,000 : 1 was 1,800 mg $O_2$/l on a sliding scale. The color was a dark orange-red. At a 1,000 : 1 dilution and a pH of 9.0, a 1-cm path length gave a purity of 20%, luminance of 57.2%, and a dominant wavelength of 613 mu. The range of the variables investigated, to determine their effect on changes in the waste during irradiation are: pH, 1.8 to 12.9; O concentration, 0 to saturation with pure O; dose rate, 0.064 to 0.334 MRad/hr; total dose, 0.17 to 2.56 MRad; waste concentration, 500 : 1 to 50 : 1 dilution. As the dose from $^{60}$Co $\gamma$ rays increased, the COD, TOC, dye concentration, and color decreased. These decreases were accompanied by an increase in Warburg oxygen uptake values showing that irradiation caused the waste to become more amenable to biological oxidation. Irradiation under alkaline conditions and in the presence of oxygen gave the largest decrease in the COD with a maximum decrease at pH 11.1. At dilutions greater than 100 : 1, irradiation caused destruction of dye molecules in the waste by a pseudo first-order reaction. At higher concentrations, deviation from first order kinetics occurred. Reactions affecting the degradation of the dye molecules were independent of the dose rates applied while oxidation of the waste as measured by the COD was dose rate dependent at higher concentrations when the dose rate was less than 0.2 MRad/hr. The measured initial differential rate of dye degradation in a 100 : 1 dilution waste sample irradiated at 0.174 MRad/hr, pH 12.1, and in the presence of oxygen was 43 mg/l/hr. This is equivalent to a G value of 0.24 molecules/100 eV, which suggests that a chain reaction is not involved in the mechanism. (Disser. Abstr.)

**45110** GAMMA RADIATION EFFECTS ON SACCHAROSE. Ibragimov, A. P.; Sultanov, A.; Tuichiev, A. V. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 4, 32-3(1968). (In Russian).

The concentration of stable, long-lived, free radicals in irradiated solid saccharose was studied using powdered saccharose irradiated with $^{60}$Co $\gamma$ rays of $10^5$ to $10^8$ RAD. The EPR spectrum of $\gamma$-irradiated saccharose revealed a clearly resolved singlet and a doublet with 14 e spallation. The concentration of radicals in the irradiated saccharose increased linearly up to $5 \times 10^{19}$ eV/g and at doses from 1 to $5 \times 10^{19}$ eV/g the magnitude $G_R$ was 2.8 radicals/100 eV. The solutions prepared from solid saccharose specimens contained hydrogen peroxide, which also increased with the radiation doses. (R.V.J.)

**45111** DEVELOPMENT OF METHODS FOR HOT SYNTHESIS OF $^{35}$S LABELED COMPOUNDS. II. PREPARATION OF

METHYLISOTHIOCYANATE-$^{35}$S. Dzantiev, B. G.; Shishkov, A. V.; Kizan, G. K. Radiokhimiya, 10: 389-91(1968). (In Russian).

The formation of $^{35}$S-labeled methyl isothiocyanate by direct irradiation in a carbon tetrachloride solution in the IRT-1000 reactor by 1 to $3 \times 10^{11}$ neutron/cm$^2$/sec flux at 50°C was studied. Electrophoresis, radiochromatographic, and sublimation methods were used in the analysis of irradiated specimens. It was shown that labeled methyl isothiocyanate-$^{35}$S is formed by sulfur atom replacement in the $CH_3NCS$ molecule by recoil atoms of $^{35}$S, produced by the reaction: $^{35}Cl(n,p)^{35}S$; $^{35}S + CH_3NCS \rightarrow CH_3NC^{35}S + S$. (R.V.J.)

**45112** GAMMA-RAY-INDUCED AMINATION OF BENZOIC ACID IN AQUEOUS AMMONIA SOLUTION. Sakumoto, Akihisa Japan Atomic Energy Research Inst., Tokyo). Nippon Ragaku Zasshi, 89: 719-20(July 1968). (In Japanese).

Irradiation of aqueous $NH_3$ solutions of $^{14}$C-carboxyl-labeled benzoic acid was carried out with $^{60}$Co $\gamma$ rays at the dose rate of $6.7 \times 10^{17}$ eV/g/min and the absorbed dose of $4.4 \times 10^{20}$ eV/g. Products were measured by an isotope dilution method. G-values of aminobenzoic acids were: ortho, 0.011; meta, 0.013; and para, 0.017. Therefore, the G-value ratio of o-:m-:p-aminobenzoic acid was 0.65:0.76:1. The production of aminobenzoic acids was about a half of hydroxybenzoic acids produced in aqueous $NH_3$ solution. From the ratio of relative partial rate factors, it was deduced that the amino radical $\cdot NH_2$ is involved in amination of benzoic acid. (NSA of Japan)

**45113** DETERIORATION OF POLYMERS BY IONIZING RADIATION. VI. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture); Imamura, Kunio. Nippon Gomu Kyakaishi, 40: 1004-7(Dec. 1967). (In Japanese).

Natural rubber and butyl rubber vulcanizates of S accelerated with various accelerators were prepared. Peroxide vulcanization was carried out for comparison with S-containing crosslinks. Effect of the nature of crosslinks on the radiation deterioration of vulcanizates was investigated by determining the crosslinking densities before and after irradiation. The S-containing crosslink had higher resistance to irradiation than the C–C crosslink and the polysulfide link was more resistant than the monosulfide one. (NSA of Japan)

**45114** RADIATION POLYMERIZATION OF ACROLEIN IN SOLID STATE. Finkel'shtein, E. I.; Gorbatov, E. Ya.; Chernyak, I. V.; Abkin, A. D. Vysokomol. Soedin., Ser. B, 10: 397 (June 1968). (In Russian).

It was verified that solid acrolein can be polymerized by $\gamma$ radiation at temperatures from 4.2 to 186°K (melting point). It was shown that at 77°K the rate of the reaction changes and is followed by a change in the structure of the polymer. The experiment proved that radiation-induced polymerization continued down to the temperature of liquid helium. (R.V.J.)

**45115** RADIATION GRAFTING OF VINYL CHLORIDE TO POLYETHYLENE AT HIGH AND LOW PRESSURES. Usmanov, Kh. U.; Kurbanov, Sh. A.; Tillaev, R. S. (Lenin Tashkent State Univ.). Uzb. Khim. Zh., No. 2, 52-5(1968). (In Russian).

Grafts of copolymers of high- and low-pressure polyethylene with vinyl chloride were synthesized by the radiation method from the vapor phase. It was shown that the yield of the copolymer graft depends on the dose, radiation output, and the presence of solvents. It was established that in grafts of vinyl chloride to low-pressure polyethylene the rupture stability is greater than in high-pressure polyethylene, but the comparative elongations are similar. The physical mechanical properties of the polyethylene and grafted copolymers with vinyl chloride were investigated. As a result of the graft to the polyethylene the heat resistance and thermal stability of the copolymer grafts are increased. The radiation stability of pure polyethylene and the copolymer grafts was studied. It was shown that the copolymer grafts are more radiation stable than pure polyethylene. (tr-auth)

**45116** METHOD FOR PRODUCING TETRAFLUOROETHYLENE TEROMER. Yoneya, Jo (to Daikin Kogyo Co., Ltd.). Japanese Patent 1967-19252. Sept. 29, 1967. Filed Oct. 4, 1963.

A method is proposed for producing a tetrafluoroethylene polymer of molecular weight from 1000 to 150,000. Tetrafluoroethylene is irradiated with ionizing radiation in the presence of at least one kind of fluorochloroalkane (which is in the liquid state at the reaction conditions) for its polymerization. At least one kind of aliphatic hydrocarbon or its derivative (which is in liquid state and is present in a molecular amount less then the monomer amount) is also added. (NSA of Japan)

**45117** METHOD FOR PRODUCING CROSS-LINKED FOAMED RESIN. Kamiyama, Mamoru (to Hitachi Chemical Industries Co., Ltd.). Japanese Patent 1967-15792. Aug. 30, 1967. Filed July 25, 1963.

A method is proposed for producing a crosslinked foamed resin, which has high resistivity for chemicals, solvents, etc., and heat, and high tensile strength. The resin can be produced in any shapes. A resin that has heat plasticity, and is crosslinked by electron irradiation, and a foaming agent, are kneaded together; and, the kneaded mixture is given a desired shape. The obtained form is irradiated by electrons while heated; the heating gives foams and the irradiation the crosslinking. (NSA of Japan)

**45118** METHOD FOR PRODUCING THERMO-PLASTIC GRAFT-COPOLYMERIZED RESINS. Watanabe, Tsutomu (to Sumitomo Bakelite Co., Ltd.). Japanese Patent 1967-22059. Oct. 30, 1967. Filed May 15, 1964.

Resins, produced by the method, have superior mechanical properties, including impact and tensile strengths, and also high thermal stabilities, all in a good balance. An aqueous emulsion of a mixture of the following is irradiated with high-energy radiation: (1) a copolymer of an aromatic vinyl compound and an acrylic compound; (2) an isobutylene polymer, an isobutylene-containing copolymer, or a mixture of the two; (3) at least one kind of aromatic vinyl monomer; and, (4) at least one kind of acrylic monomer. (NSA of Japan)

**45119** METHOD FOR WORKING FOAMED MATERIALS. Kamiyama, Mamoru (to Hitachi Chemical Industries Co., Ltd.). Japanese Patent 1967-22313. Nov. 1, 1967. Filed Aug. 28, 1963.

A method is proposed for attaching a foamed material onto a sheet or plate. The advantages are simple operation, strong adhesion, and fair product. A mixture of a bridgeable thermoplastic resin, a heat-hardening resin, and a foaming agent (if necessary, bridging, hardening, etc., agents) is molded into the shape of a sheet or plate. Then, the plate is heated at a temperature below the dissociation temperature of the foaming agent and irradiated with electrons if necessary. The plate is then attached on the object plate, and the whole is heated at a temperature above the dissociation temperature of the foaming agent, or, omitting the (above) second step, the molded sheet is attached directly on the object plate, and the whole is heated at a temperature above the dissociation temperature of the foaming agent. (NSA of Japan)

**45120** METHOD FOR IMPROVING THE QUALITY OF VINYL CHLORIDE RESIN. Tachimori, Monji (to Hitachi Ltd.). Japanese Patent 1967-16421. Sept. 5, 1967. Filed Feb. 5, 1964.

The quality of vinyl chloride resin is improved by adding the diallyl ester of bicyclo-[2.2.1]-heptene-5-dicarboxylic acid-2,3 and then irradiating the mixture with ionizing radiation to produce crosslinking. (NSA of Japan)

**45121** POLYMETHYLENE SYNTHESIS FROM CARBON MONOXIDE AND HYDROGEN ON RUTHENIUM CATALYSTS. 12. SYNTHESIS UNDER THE INFLUENCE OF $\gamma$ RAYS. Pichler, H.; Burgert, W.; Gabler, W.; Kioussis, D. (Univ., Karlsruhe, Ger.). Brennst.-Chem., 49: 36-40(Feb. 1968). (In German).

A polymethylene fraction of molecular weight 70,000 was $\gamma$ irradiated ($^{60}$Co) in the presence of air, giving a lowered mp (from 134 to 129°C) and carbonyl absorption; in vacuum $H_2$ was evolved on irradiation, proportionately to the dose, the mp rising to 154 to 184°C, and solubility in toluene decreasing. Fractions of molecular weight 18,000 showed no mp rise on irradiation; those above 18,000 had a rise. The ir spectra of polymethylene and polyethylene films of molecular weight 100,000 were compared before and after irradiation. The former showed less $CH_3$ branching (8 $CH_3$/1000°C) and no vinyl groups. Both samples showed formation of trans-vinylene groups. Irradiation during synthesis at 200 and 120°C showed 30 to 40% increase in exchange over unirradiated samples. Synthesis with irradiation over 48 hr gave samples with no different mp characteristics. At mean pressures of 1000 atm and times of 568 hr the irradiated material had a maximum mp of 184°C while irradiated material had maximum mp of 131 to 135°C. (BBB)

**45122** METHOD FOR PRODUCING FOAMED RESIN PRODUCTS WITH ELECTRON-RAY BRIDGING. Kamiyama, Mamoru (to Hitachi Chemical Industries Co., Ltd.). Japanese Patent 1967-22314. Nov. 1, 1967. Filed Aug. 28, 1963.

A method is described for producing adiabatic, sound-absorbing materials having high chemical and heat resistances, high tensile strength, and high adhesive power in desired shapes. A mixture of an electron-bridgeable thermoplastic resin, a heat-hardening resin, and a foaming agent (if necessary, other additives) is kneaded and molded into a desired shape. Then, the molding is irradiated with electrons while heating at a temperature below the dissociation temperature of the foaming agent. Finally, it is heated at a temperature above the dissociation temperature of

the foaming agent. Or, after the (above) first step, the molding is irradiated with electrons while heated at a temperature above the dissociation temperature of the foaming agent. (NSA of Japan)

**45123** RADIO-POLYMERIZATION OF VINYL FLUORIDE WITH POLYMETHYLMETHACRYLATE IN THE PRESENCE OF SOLVENTS. Usmanov, Kh. U.; Yul'chibaev, A. A.; Asamov, M. K. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR, No. 4, 24-6(1968). (In Russian).

Polymerization of vinyl fluoride (VF) with poly(methyl methacrylate) (PMMA) in benzene or dichloroethane solution induced by 10 to 150 r/sec $^{60}$Co $\gamma$ rays at 38°C was studied. The copolymer was separated from the homopolymer by dissolution in acetone and precipitation by distilled water. The irradiated PMMA and copolymer had a lower viscosity and higher thermal stability than the initial PMMA. The data obtained confirmed the efficiency of radiopolymerization of PMMA with VF in solvents. (R.V.J.)

**45124** STRUCTURE AND REACTIVITY OF PROPYL IONS IN GAS-PHASE RADIOLYSIS. Ausloos, P.; Rebbert, R. E.; Lias, S. G. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc., 90: 5031-3(Aug. 28, 1968).

Values are reported for the propyl ions $CD_3CDCD_3^+$ and $CD_3CD_2CD_2^+$ formed in the rare gas-sensitized radiolysis of n-$C_4D_{10}$–n-$C_4H_{10}$ mixture carried out in the presence of $O_2$ as a radical scavenger. The formation of the sec-$C_3D_7^+$ ion is more important in the krypton-sensitized radiolysis where the parent n-$C_4D_{10}^+$ ion is formed with 1 to 2 eV more energy than in the xenon-sensitized radiolysis. When n-$C_4D_{10}$–n-$C_4H_{10}$ mixtures were irradiated in the presence of varying amounts of $NH_3$, a decrease in the yield of propane and an increase in the propylene yield as a function of the $NH_3$ concentration was observed. Cyclopropane was formed in the radiolysis of n-$C_4H_{10}$–$NH_3$ mixture with a yield that increased as the $NH_3$ concentration. In contrast, no cyclopropane was formed in the radiolysis of isobutane–$NH_3$ mixture. Results thus indicate that propyl ions having two distinct structures undergo the reaction $C_3D_7^+ + C_4H_{10} \rightarrow C_3D_7H + C_4H_9^+$. (D.H.M.)

**45125** ABSTRACTION OF HYDROGEN FROM HYDROCARBONS BY ENERGETIC TRITIUM ATOMS. Tachikawa, Enzo; Rowland, F. S. (Univ. of California, Irvine). Contracts AT(11-1)-407; AT(11-1)-34. J. Amer. Chem. Soc., 90: 4767-73(Aug. 28, 1968).

The correlation of increasing HT yield with decreasing RH bond dissociation energy was confirmed for recoil tritium reactions with hydrocarbons in a series of moderators: c-$C_4F_8$, 1,3-$C_4F_6$, Ar, and $N_2$. The correlation is the same in both gas- and liquid-phase experiments with c-$C_4F_8$, indicating that the abstraction mechanism is quite similar in both phases. The precision of the relative HT yield measurements is much greater than that of the bond dissociation energies available for comparison. The per bond yields of HT vary by a factor of 8 between cyclopentane and acetylene. Variations of this magnitude can be explained by an energy cut-off model, in which the weaker C–H bonds both permit abstraction at lower energies and also increase the probability of reaction per collision in the energy range available for reaction. The HT yield from a given molecule, RH, varies in the ratio $4.7 \pm 0.2 : 2.2 \pm 0.1 : 1.0$ when RH is present at the same low mole fraction in the moderators Ar/$N_2$/c-$C_4F_8$. The average logarithmic energy loss is about twice as large in $N_2$- as in Ar-moderated systems. (auth)

**45126** FORMATION OF SOLUTE EXCITED STATES AND RADICALS DURING PULSE RADIOLYSIS OF NAPHTHALENE IN ETHEREAL SOLUTIONS. Kemp, T. J.; Roberts, J. P. (Univ. of Warwick, Coventry, Eng.). Trans. Faraday Soc., 64: 2106-11 (Aug. 1968).

Yields of solute radicals and triplet and singlet excited states were found to differ markedly for solutions of naphthalene in two ethers, 1,2-dimethoxyethane (DME) and tetrahydrofuran (THF), which have almost the same dielectric constant (7.2 and 7.4, respectively, at 25°C). The concentration dependences revealed that in both solvents the production of radicals and excited states are not inter-related in a simple manner; production of singlet and triplet states do, however, seem to be related. (auth) (UK)

**45127** STEREOSPECIFICITY OF THE RECOMBINATION REACTIONS IN THE NEUTRON IRRADIATED CIS- AND TRANS-[Cr(ETHYLENEDIAMINE)$_2$Cl$_2$]Cl. Jagannathan, R.; Mathur, H. B. (National Chemical Lab., Poona). J. Inorg. Nucl. Chem., 30: 1663-7(Aug. 1968).

A high degree of stereospecificity was observed in the recombination reactions during neutron irradiation and subsequent thermal annealing of cis- and trans-[Cr(en)$_2$Cl$_2$]Cl. (auth)

**45128** RADIATION REDUCTION OF Hg AND Cu FROM SOLUTIONS AND SALTS. Razmadze, N. A.; Khomasuridze, Zh. F.; Nanobashvili, E. M. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 50: 625-30(June 1968). (In Russian).

The radiochemical transformation of mercury and copper in aqueous solutions and the presence of organic additives and solvents was studied using systems containing Hg and Cu irradiated by $^{60}$Co $\gamma$ rays. Data obtained on the radiolysis of $CuSO_4$–$NaH_2PO_2$–$H_2O$ and $Cu(NO_3)_2$–$NaH_2PO_2$–$H_2O$ showed that copper ions are effectively reduced in the systems. Radiolysis of alcohol solutions of Hg salts revealed that reduction of ions in the case of mercury acetate is more efficient than in mercury chloride. In the radiolysis of copper and mercury aqueous solution the presence of organic additives improved the reduction of the metals studied. (R.V.J.)

**45129** USE OF THE EMANATION METHOD FOR THE STUDY OF THE PRODUCTS OF THE RADIATION-THERMAL MODIFICATIONS OF POLYETHYLENE. Bekman, I. N.; Zaborenko, K. B. Radiokhimiya, 10: 382-5(1968). (In Russian).

The study of the products of the radiation-thermal modification of polyethylene by physiochemical methods of analysis (emanation, differential thermal, and dilatometric analyses) showed that in the absorbed dose interval studied from 0 to 2000 Mrad the form of the emanogram depends on the size of the dose and reflects structural changes caused by the irradiation. The possibility of detecting annealing processes of the radicals by means of a comparison of the emanograms of the first and repeated heatings was shown. (tr-auth)

**45130** EFFECT OF ALCOHOLS ON THE GAMMA-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Suganuma, Fujio; Machi, Sueo; Mitsui, Hiroshi; Hagiwara, Miyuki; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1, 6: 2069-78(Aug. 1968).

Gamma radioinduced polymerization of ethylene in alcohols such as methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, and n-pentyl alcohols was carried out under a pressure of 400 kg/cm$^2$ at 30°C at a dose rate of $1.4 \times 10^5$ RAD/hr in a batch reactor of 100 ml capacity. The yield and molecular weight of polymer formed in the alcohols (except tert-butyl alcohol) were much lower than those of the bulk polymerization under the same conditions, whereas the addition of tert-butyl alcohol increased the yield and reduced the molecular weight. From the infrared spectra of the polymers and those of the bromination products it was concluded that only primary OH exists in the polymer formed in methyl alcohol and that both primary and secondary OH are in the polymer formed in other primary alcohols. Both secondary and tertiary OH were observed in the polymer when the secondary alcohols were used, and only tertiary OH in the case of tert-butyl alcohol. These polymers were found to contain small amounts of unsaturated vinylidene and methyl groups. On the basis of these results the roles of the alcohols in the polymerization are discussed. (auth)

**45131** KINETICS OF METHYL ALCOHOL RADIOLYSIS AT 77°K. Tikhomirov, L. A.; Pavel'ev, V. S.; Buben, N. Ya. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 2: 284-6 (May-June 1968). (In Russian).

In order to determine the mechanism resulting in free radical destruction, studies were made of products of radiolysis of solid organic substances. Methyl alcohol radiolysis was analyzed using specimens irradiated with $^{60}$Co $\gamma$ radiation of 0.04 to 0.11 Mrad/min at 77°K and in an accelerator with 1.6-MeV electrons with doses of 6 Mrad/min at 100°K. Concentrations of radicals were studied simultaneously with concentrations of ethylene glycol and formaldehyde which are the basic condensation products of methanol radiolysis at low temperatures. The results revealed that the basic reaction of radical destruction by irradiation at 77°K is caused by the breaking away of the hydrogen atom. (R.V.J.)

**45132** EPR STUDIES OF FORMATION AND TRANSFORMATION OF RADICALS DURING IRRADIATION OF FROZEN HYDROUS LACTOSE SOLUTIONS. Sharpatyi, V. A.; Nadzhimiddinova, M. T.; Kudryashov, L. I.; Bortsova, E. I. (Inst. of Chemical Physics, Moscow. Inst. of Organic Chemistry, Moscow). Khim. Vys. Energ., 2: 286-7(May-June 1968). (In Russian).

Previous EPR spectral studies on the radiolysis of frozen neutral aqueous solutions of disaccharides and monosaccharides revealed a hydrated electron, $e_{hyd.}$, and a paramagnetic particle (a singlet, $\Delta H \approx 5e$, stable up to –80 to –60°C) which is a molecular ion ($M^-$, $R_{II}$, and $R_{IV}$) formed by an electron joining to the sugar molecule or by an electron stabilizing the sugar, M + e = $M^-$. EPR studies were made of the formation and transformation of radicals in frozen lactose solutions at various pH, concentrations, and temperatures. Concentration of radicals in neutral and alkali lactose solutions (20%), irradiated with 1.5 to 2 Mrad electrons at –150°C was near the maximum and at 7 to 8 Mrad the concentration dropped to the minimum 0. Chemical

data on the structure of products formed during radiolysis of aqueous lactose solutions are in good agreement with the concepts of $M^-$ formation in initial studies of radiolysis. (R.V.J.)

**45133** RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF IRRADIATION ATMOSPHERE ON VISCOSITY. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Appl. Polym. Sci., 12: 2183-6(Sept. 1968).

When protein is irradiated by $\gamma$ rays from a $^{60}Co$ source in various atmospheres such as $N_2$, $CO_2$, $H_2$, $O_2$, and $NH_3$, the effect of the radiation varies with the gases composing the irradiation atmosphere. An empirical equation for the viscosity change was obtained. (auth)

**45134** CROSSLINKING POLY(ETHYLENE OXIDE) IN DILUTE SOLUTIONS BY GAMMA RAYS. Van Brederode, R. A.; Rodriguez, F.; Cocks, G. G. (Cornell Univ., Ithaca, N. Y.). J. Appl. Polym. Sci., 12: 2097-2104(Sept. 1968).

A high-molecular-weight poly(ethylene oxide) is gelled by radiation from a $^{60}Co$ source. At concentrations of 0.25 to 1 wt %, doses of 4.5 to $7.5 \times 10^4$ rad cause gelation. The storage modulus of the gel formed increases linearly with additional dose to a plateau value and then remains constant during further irradiation. The dose needed to reach the plateau, $D_p$ in rads, and the plateau modulus $G_p$ in dynes per square centimeter, are related to the concentration c, in weight per cent: $D_p = 1.05 \times 10^6 c$ and $G_p = 1.75 \times 10^4 c^{2.5}$. The energy absorbed by the polymer per crosslink formed is about 80 ± 10 kcal/mol. The crosslink density produced by radiation is calculated from the measured modulus by using the theory of rubber elasticity. Both modulus and loss are measured in a special air-bearing, recording torsion pendulum with a cone-plate geometry. (auth)

**45135** IMPROVEMENTS IN OR RELATING TO COTTON FIBRE PRODUCTS. (to Atomic Energy of Canada Ltd.). British Patent 1,126,272. Sept. 5, 1968. Priority date May 18, 1965, Canada.

A mixture of styrene and methyl methacrylate is graft polymerized onto cotton by immersing the cotton in a solution of the styrene and methyl methacrylate in methanol and/or ethanol and water (up to 10 vol %), and subjecting the cotton during immersion to $\gamma$ radiation at dose rate of $1 \times 10^5$ to $7 \times 10^5$ RAD/hr for a total dose of $3 \times 10^5$ to $1 \times 10^6$ RAD. (B.L.M.)

**45136** STUDY OF RADIATION-INDUCED GRAFT POLYMERIZATION OF VINYL MONOMERS TO CELLULOSE BY INFRARED SPECTROSCOPY. II. CELLULOSE–POLYSTYRENE COPOLYMERS. Imrisova, D.; Maryska, S. (State Textile Research Inst., Brno). J. Appl. Polym. Sci., 12: 2007-11(Sept. 1968).

Infrared spectral analysis was applied for the study of cotton–polystyrene copolymers prepared by using the preirradiation method. The degree of grafting was determined from absorption at 700 $cm^{-1}$, which is characteristic of the polystyrene spectrum, with an accuracy of ±1.5%. (auth)

## Radiochemistry

*Refer also to abstracts 45156 and 45292.*

**45137** DETERMINATION OF THE DECAY RATE OF CARRIER-CONTAINING RADIOACTIVE PREPARATIONS BY THE $4\pi$ $\beta$-$\gamma$ COINCIDENCE METHOD. Menke, H.; Fahland, J. (Univ., Mainz). Nukleonik, 11: 179-81(July 1968). (In German).

The absolute activity of preparations with carrier amounts between 10 and 50 mg was determined by the $4\pi$ $\beta$-$\gamma$ coincidence method. The method was tested with 15 radionuclides with maximum $\beta$ energies between 0.3 and 3 MeV. The measurements on carrier-containing preparations were controlled by comparison with carrier-free preparations. The results agreed within ±3%. The measurements of 2.58-hr $^{56}Mn$, 85-min $^{139}Ba$, and 54-min $^{113m}In$ showed that the method can also be used for determination of the decay rate of short-lived nuclides. (tr-auth)

## Separation Processes

*Refer also to abstracts 44995, 45015, 45029, 45059, 45069, 45090, 45208, and 45306.*

**45138** (ANL–7385) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XVII. FLUORINATION OF NEPTUNIUM(IV) FLUORIDE AND NEPTUNIUM(IV) OXIDE. Trevorrow, L. E.; Gerding, T. J.; Steindler, M. J. (Argonne National Lab., Ill.). Apr. 1968. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

Rates of formation of $NpF_6$ by the reactions of $NpF_4$ with $BrF_3$ (6 to 13 m% in nitrogen) or $BrF_5$ (33 to 35 m% in nitrogen) or fluorine (100 m%) were studied at 250 to 400°C and were interpreted in terms of a rate law that assumes that reaction occurs at a continuously diminishing spherical interface. The relative rates of reaction of $NpF_4$ with the fluorinating agents at the given concentrations and at 350°C were in the following order: fluorine > $BrF_3$ > $BrF_5$. Correlation of the derived rate constants by the Arrhenius equation yielded activation energies of 20 kcal/mole for the reaction of $NpF_4$ with fluorine and 26 kcal/mole for the reaction of $NpF_4$ with $BrF_5$. Examination of the solid residues from the reactions of $NpF_4$ with $BrF_5$ or fluorine by chemical and x-ray-diffraction powder analyses indicated the presence of no species other than $NpF_4$. The fluorination of $NpO_2$ by either $BrF_5$ or fluorine proceeds through the intermediate compound $NpF_4$. Thus, the fluorination of $NpO_2$ is analogous to that of $PuO_2$, which proceeds through the intermediate compound $PuF_4$, but is not analogous to the fluorination of $UO_2$, which proceeds through the intermediate compound $UO_2F_2$. (auth)

**45139** (ARH-SA–9) RECLAMATION OF A PARTIALLY PLUGGED GLASS FIBER VENTILATION FILTER AT THE HANFORD PUREX NUCLEAR FUELS REPROCESSING PLANT. Clark, B. E.; Davis, D. F.; Schmidt, W. C. (Atlantic Richfield Hanford Co., Richland, Wash.). July 31, 1968. Contract AT(45-1)-2130. 21p. (CONF-680811–6). Dep. CFSTI.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York.

Canyon ventilation air from the Hanford Purex Nuclear Fuels Reprocessing plant is exhausted through a filter system before being released to the atmosphere. The filter installation consists of a bulk-particulate removing, glass fiber fore-filter, and a fine-particulate removing, high efficiency, glass fiber after-filter. The original filter installation was built in 1955 during plant construction and operated satisfactorily until early 1964 when the fore-filter indicated a loss of capacity because of particulate loading. Construction of a new filter installation was started immediately and it was put into operation in 1965. When plugging of the original filter became evident, a program was initiated to define the cause of the problem and to develop, if possible, a way to reclaim the filter without damaging it. Samples of filter entrance air indicated a large percentage of the particulate to be crystalline ammonium nitrate. Core samples of the fore-filter glass fiber bed showed a predominantly ammonium nitrate loading confined to the inlet side of the bed. In a laboratory unit, an ammonium nitrate loading was shown to displace and disperse in the glass fiber bed, with resulting reduced pressure drop for a given air flow, by passing highly humidified air through the glass fiber bed. Based on the laboratory studies the partially plugged original filter, after removal from operation, was treated for reclamation using a small flow of highly humidified air through the fore-filter. The results of the reclamation treatment were satisfactory and it was possible to return the original filter installation to service handling the entire exhaust ventilation flow. The filter was reclaimed at a cost of $15,000; the filter replacement cost $750,000. While the reclaimed filter again developed a high pressure drop after five months of service and is not now in service, it remains useful as an emergency back-up to the replacement filter. (auth)

**45140** (BMwF-FBK–68-08) APPLICATION OF MECHANICAL SEPARATION AND SOLID-STATE REACTIONS TO THE REPROCESSING OF CERAMIC NUCLEAR FUELS. Lux, F.; Wuermseher, H. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Mar. 1968. 54p. (In German). Dep.

The system uranium dioxide–uranium carbide–graphite–irradiation products of uranium was examined between 1000 and 2300°C; the macroscopic solid phases were finely divided. Mechanical data such as grain distribution, density, intergrowth etc. and conditions of reactions in the system were determined. A method for solid-solid separation was developed for the system. Below 2000°C the following values were found for the release of nonvolatile fission products from the neutron-irradiated phase: 100% Ba, 26% Zr/Nb, 16% Mo, 51% Ru, 51% Ce, 70% Nd. It was possible to explain the release by microscopic heterogeneous solid-state reactions. The possible application of these results to reprocessing of nuclear fuel is discussed. (auth)

**45141** (EURAEC–2030) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 30, July 1–September 30, 1967. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7-RCIB(RD); 016-65-1-RAP-B. 76p. (EUR–3984). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

With a view to using chlorine trifluoride as a fluorinating agent to etch ceramic fuel in compact form, the study of the volatilization of uranium, from high density microspheres and for different plutonium contents, was continued by thermogravimetry. For the

composite oxide with 25% plutonium, the volatilization of the uranium stops at 90% at temperatures of 250 and 300°C, but is complete at 350°C. With regard to the uranium volatilization rate, an anomaly was found, these rates being higher for the composite oxides than for the pure uranium dioxide. In contradiction with those of earlier tests, these results seem to be due to the special state (presence of impurities, structures, etc. . .) of the material used. Construction of the different appliances which will constitute the fuel assembly treatment unit is continuing. Chemical decanning tests were carried out on sub-assemblies of 19 elements 50 cm long in a column 10 cm in diameter. Complete decanning and total pulverization of the uranium dioxide pellets were obtained on this scale in the absence of alumina. With alumina present, agglomerates were formed. Analyses of the residua of these reactions are in progress. Variance analysis applied to the chlorine trifluoride reaction, on uranium dioxide pellets with fissium to determine the importance of the different parameters was continued. In addition, the influence of the temperature between 300 and 500°C on the volatilization rate and the fluoride utilisation efficiency of this reaction were examined. The rate and efficiency varied little between 300 and 500°C. But, as from 450°C, solidification between the pellets and the alumina occurred. A study on samples of an alumina-uranium tetrafluoride mixture was effected with a view to developing a sampling procedure making it possible, by means of a small number of analyses, to determine the total quantity of uranium or plutonium retained, by filtration, in the fixed alumina bed situated immediately after the volatilization reactor. In hot technology, the assembling of the hot thermobalance and the storage cell, the transforming and conditioning of the samples are continuing. Operating tests were carried out on the hot semi-pilot equipment. In the plutonium laboratory, two preliminary fluorination tests were effected on uranium dioxide pellets with 2% of plutonium dioxide by chlorine trifluoride. The mechanical decanning study and the health physics calculations are continuing. (auth)

**45142** (IS-T-259) CORRELATION OF DROP SIZES IN A PULSED EXTRACTION COLUMN. Miller, Nicholas Carl (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 55p. Dep. CFSTI.

Thesis.

In attempts to find a correlation, drop size data were analyzed for several operating conditions and four liquid systems in a sinusoidally pulsed column. The variables investigated were plate hole diameter, per cent free area, frequency and amplitude of pulse, and the physical properties of the two liquids. The following equation was suggested by dimensional analysis: $D_D/D_N = 1.3036\ Pf_j^{0.05515} Bo^{-0.2045} M^{-0.92854}$. This equation predicted the 144 measured drop diameters with an average deviation of 8.3%. (auth)

**45143** (K-1734) NUCLEAR SAFETY STUDIES FOR LOW-ENRICHMENT FLUORIDE VOLATILITY FUEL REPROCESSING PLANTS. Habiger, K. E.; Breton, D. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 4, 1968. Contract W-7405-eng-26. 66p. Dep. CFSTI.

Conceptual and hardware development studies are being made relative to the design of fluoride volatility fuel reprocessing plants for low-enrichment nuclear reactor fuels. As a part of this effort, criticality calculations were made to establish reactivities of various assemblies of uranium and plutonium with other volatility process materials. These results were then used as bases for estimating the geometry or fissile mass limitations for the conceptual plant processing equipment. The DTF-II and ANISN one-dimensional $S_n$ multigroup transport codes were used in the $S_4$ option for the calculations. For uranium, calculations were made for cases involving homogeneous mixtures of uranium dioxide and alumina, uranium dioxide and water, uranium hexafluoride and hydrogen fluoride, and disodiumoctofluorouranate and sodium bifluoride. The maximum $^{235}U$ assay considered was 5%. Included in the plutonium studies were calculations for plutonium dioxide, plutonium hexafluoride, and plutonium tetrafluoride-sodium fluoride complex; calculations were also made for homogeneous mixtures of plutonium dioxide and water, plutonium dioxide and alumina, plutonium hexafluoride and hydrogen fluoride, and plutonium tetrafluoride-sodium fluoride complex and sodium bifluoride. Various geometries, including cylinders, spheres, and slabs were considered. In the plutonium studies, all plutonium was assumed to be $^{239}Pu$ except in one calculation series where a plutonium isotopic distribution similar to that expected in spent light water reactor fuel was considered. It was concluded that, based on the assumptions made, it should be possible to design most of the equipment in a volatility plant to be geometrically safe for uranium and plutonium, provided water is excluded from the process vessels. Mass control for plutonium might be necessary in large vessels, however, if the possibility of plutonium segregation is allowed. (auth)

**45144** (K-1745) ENGINEERING DEVELOPMENT OF AN ABSORPTION PROCESS FOR THE CONCENTRATION AND COLLECTION OF KRYPTON AND XENON. Second Summary Progress Report, July–December 1967. Merriman, J. R.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 19, 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

One of the most direct methods for stripping krypton and xenon from contaminated gas streams is selective absorption in a fluorocarbon solvent, such as refrigerant-12. A development program is under way to establish engineering scale-up data required for design of plants using the absorption technique for processing gases containing radioactive krypton and xenon isotopes. The scope of the work includes pilot plant testing, conceptual design studies for various plant-scale applications of the processes, and optimization studies. During this report period, construction and procurement of the pilot plant equipment items were essentially completed, and installation was begun. The conceptual design effort was temporarily reduced pending collection of pilot plant data to guide the selection of promising plant operating conditions. The basic material balance model used in the optimization work has been constructed, programmed, and tested; and equipment sizing and costing routines are currently being developed for incorporation into the material balance code. (auth)

**45145** (K-1754) A STUDY OF POLLUTANT DISCHARGES FROM REACTOR OPERATIONS UTILIZING ULTRACENTRIFUGATION TECHNIQUES. Amburgey, J. W. Jr. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 19, 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Reactor cooling water samples from the Hanford Operation at Richland, Washington, have undergone particulate separations and study utilizing recently developed ultracentrifugation techniques. The suspended particles contained in these samples were separated into classified groups and then subjected to a variety of analytical investigations including elemental and radiochemical analyses. The samples selected for study were taken in sets ranging from one to four samples per set. Six sets or a total of sixteen samples were collected and shipped to the Biophysical Limnology Laboratory at Oak Ridge for study. The analytical results from these investigations are summarized in a series of tables. The content of selected elements and the radioactivity for the more prominent radionuclides are shown as associated with either the particulate or the dissolved fractions contained in the original sample volume. A few radionuclide parent elements such as chromium, sulfur, and zinc were found almost entirely associated with the dissolved materials fraction. These results along with other data showed that the suspended materials isolated from the various samples of reactor cooling water did not add significantly to the production of radionuclides and the radioactive pollution of the Columbia River at Hanford. (auth)

**45146** (NP-17588) THIRD REPORT ON THE ACTIVITIES OF THE EUROCHEMIC COMPANY, 1964–1966. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). 218p. Dep.

Research progress is reported under the following headings: safety at Eurochemic, hot cells, Janus cell assembly, head-end processes, pilot equipment, pilot-scale decanning, pilot-scale dissolution, U-Mo fuel element dissolution, Citriflex process for Zircaloy decanning, miscellaneous studies, extraction-evaporation pilot plant, highly enriched uranium fuel reprocessing, uranium(IV) nitrate as reducing agent for plutonium, electrolytic preparation of uranium(IV) nitrate, stability of uranium(IV) solutions, uranium-plutonium separation, final purification of plutonium, direct precipitation of plutonium oxalate, laboratory purification of plutonium from EL-1 fuel elements, final treatment of medium-level waste, solidification methods, treatment of waste from U-Mo alloy fuels, concentration of Zirflex waste, feasibility of high-level waste fixation in glass, analytical development, analytical methods for process control, development of analytical laboratory equipment, in-line instrumentation, second plant dissolver, plutonium tail-end, reprocessing of highly enriched uranium fuels, high-level waste storage, medium-level waste storage, low-level waste treatment, plant construction, commissioning the plant, first active test run, and plant operation. (M.C.G.)

**45147** (NYO-3462-4) STABLE ISOTOPE STUDIES. Annual Progress Report, July 15, 1967–August 15, 1968. Spindel, William (Yeshiva Univ., New York. Belfer Graduate School of Science). Contract AT(30-1)-3462. 29p. Dep. CFSTI.

Preliminary studies are reported on the dependence of the fractionation factor for nitrogen exchange in the $N_2O_3$ – NO and $HNO_3$ – NO systems as a function of temperature, pressure, and concentrations. These studies aim at an examination of the feasibility of using a dual-temperature process for nitrogen isotope

concentration. The temperature dependences of isotopic exchange equilibria of a number of oxynitrogen compounds were examined. "Anomalies" including inflections, maxima and minima, and "crossovers" in a plot of log K vs T were found to be fairly prevalent. The significance of the prevalence of temperature-dependence "anomalies" is discussed. Several approximation methods for predicting isotope effects were tested on the partition-function ratios of a number of oxynitrogen molecules and on the equilibrium constants for exchanges among them. The validity of the various approximation methods was critically examined. An improved method for using orthogonal polynomials for expansion of the reduced partition function ratio of isotopic molecules is described. Numerous model calculations indicate the effectiveness of this expansion technique. (auth)

**45148** (ORNL-tr-1785) THE CENTER AT LA HAGUE. Duboz, M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Energ. Nuc. (Paris), 7: 228-45(1965). 39p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 40273.

**45149** (RT/PROT-(68)8) TRANSIENT ANALYSIS FOR EXPLOSIVE PERTURBATIONS IN THE VENTILATION SYSTEM OF EUREX REPROCESSING PLANT. Perinetti, M.; Zaffiro, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 57p. Dep.

Transient phenomena occurring along the ventilation system of the EUREX reprocessing plant after an explosion in a process cell, were considered. Fundamental equations that describe the behavior of the plant during transient conditions are presented and a mathematical approach to solve them with the help of an analog computer was developed so that pessimistic results are obtained. Several analog runs were investigated and results are reported and discussed. The structural integrity of high-efficiency particulate filters was evaluated when considering the effects of abnormal conditions caused by explosions. An appendix was included to provide information on the analog circuit. (auth)

**45150** STATUS AND OUTLOOKS FOR THE REPROCESSING OF IRRADIATED FUELS IN SPAIN. Perez, B. Lopez; Jodra, L. G. pp 151-64 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Fuel reprocessing facilities, including the Hot Plant M-1, the CIES pilot plant, and the Hot Cell M-2, are described. Future outlooks on fuel reprocessing in Spain are considered along with financing. (M.C.G.)

**45151** DECONTAMINATION OF RADIOACTIVE EFFLUENT BY MEANS OF ZEOLITES. Verot, J.-L.; Blum, J. M. Energ. Nucl. (Paris), 10: 210-13(May 1968). (In French).

The decontamination of radioactive effluents by means of zeolites was studied using synthetic zeolytes and synthetic effluents in order to determine the best conditions for the fixation of $^{90}Sr$, $^{95}Zr$, $^{106}Ru$, $^{137}Cs$, and $^{144}Ce$, taken alone or in mixture. The results obtained are tabulated and show that this decontamination procedure is very efficient. Ce, Cs, Sr, and Zr and their decay products are eliminated under conditions so that their concentration is lowered to the vicinity of the maximum permissible concentration. The reduction factors obtained are approximately 3 to 5 times greater than those obtained during conventional treatment by coprecipitation. The results obtained for Ru are encouraging; there is at least one form of this element capable of being fixed by zeolites. (J.S.R.)

**45152** EXTRACTION OF AMERICIUM(III) AND EUROPIUM (III) BY DINONYLNAPTHALENE SULPHONIC ACID AND ITS SALTS. Khopkar, P. K.; Narayanankutty, P. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem., 30: 1957-62(Aug. 1968).

Equilibrium constants for the exchange of monovalent cations with hydrogen ions in dinonylnaphthalenesulfonic acid (HDNNS) dissolved in n-hexane and chloroform were determined at an ionic strength of unity. Extraction of Am(III) and Eu(III) from various acids and salt solutions containing the monovalent cations was studied with reference to the selectivity of $DNNS^-$ for these ions. (auth) (UK)

**45153** RADIOCHEMICAL PURIFICATION OF MICROGRAM AND SUB-MICROGRAM AMOUNTS OF BERYLLIUM. Piper, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Anal. Chim. Acta, 42: 423-9(Sept. 1968).

A method is presented for the separation and radiochemical purification of microgram and tracer amounts of beryllium from solutions. It is a four-stage ion-exchange procedure consisting of selective adsorption of the beryllium onto NaDAP resin and its elution with ammonium fluoride; adsorption of the fluoroberyllate complex onto an anion-exchange column and elution of the beryllium with hydrochloric acid; adsorption and selective elution of the beryllium on a cation-exchange column; a pass through an anion-exchange column in concentrated hydrochloric acid. The method is quantitative and requires no carrier. Decontamination factors from most radionuclides tested were greater than 10,000. The method can be used to determine $^{10}Be$ in environmental materials. (auth)

**45154** ACIDIC ORGANOPHOSPHORUS EXTRACTANTS. VI. EXTRACTION OF CALCIUM AND STRONTIUM BY DIOCTYL PHOSPHORIC ACIDS IN VARIOUS DILUENTS. Sistkova, N. V.; Kolarik, Z.; Barta, K.; Pankova, H. (Nuclear Research Inst., Rez, Czech.). J. Inorg. Nucl. Chem., 30: 1595-1603(July 1968).

The solvent extraction of Ca(II) and Sr(II) by di-n-octyl and bis(2-ethylhexyl) phosphoric acids was studied radiometrically. n-Heptane, cyclohexane, butyl ether, carbon tetrachloride, and toluene were used as diluents. The effect of extractant structure and diluent nature on the composition of Ca(II) and Sr(II) complexes in the organic phase as well as on the efficiency of Ca(II) and Sr(II) extraction and separation is discussed. (auth)

**45155** APPARATUS AND MATERIALS FOR HYPERPRESSURE GAS CHROMATOGRAPHY OF NONVOLATILE COMPOUNDS. Karayannis, Nicholas M.; Corwin, Alsoph H.; Baker, Earl W.; Klesper, Ernst; Walter, Joseph A. (Johns Hopkins Univ., Baltimore). Anal. Chem., 40: 1736-9(Sept. 1968).

A hyperpressure gas chromatograph was developed in order to extend studies on the development of gas chromatography under high pressures as an analytical or preparative method for nonvolatile organic, organometallic, and inorganic compounds. The suitability of various column packing materials is evaluated. Separations were achieved between various types of metalloporphyrins and between various metallic chelates of acetylacetone. (J.G.B.)

**45156** CHEMICAL STATE OF $^{125}I$ IN NEUTRON-IRRADIATED $XeF_2$ AND SEPARATION OF CARRIER-FREE $^{125}I$. Zaitsev, V. M.; Kirin, I. S.; Tikhonov, V. I. Radiokhimiya, 10: 391-3(1968). (In Russian).

The chemical state of $^{125}I$ ($T_{\frac{1}{2}}$ = 58 days and $E_\gamma$ = 35.5 keV) in neutron-irradiated xenon was studied. A method was developed for the separation of carrier-free $^{125}I$ from the irradiated $XeF_2$ according to the reaction $XeF_2 + 2\ NaOH \rightarrow Xe + \frac{1}{2}\ O_2 + 2\ NaF + H_2O$. (R.V.J.)

**45157** EXTRACTION OF SOME HEAVIER LANTHANIDES IN ACIDIC CHLORIDE SOLUTIONS BY Di(2-ETHYLHEXYL) PHOSPHORIC ACID. Owens, Thomas C.; Smutz, Morton (Iowa State Univ., Ames). J. Inorg. Nucl. Chem., 30: 1617-33(July 1968).

Equilibrium data were obtained for the systems $MCl_3$–HCl–$H_2O$–1 M D2EHPA (in Amsco Odorless Mineral Spirits), where M is used to designate the trivalent lanthanides Gd, Dy, Er, and Yb, over a wide concentration range of the lanthanide chloride in aqueous solution. For a particular acidity and a given lanthanide concentration in the aqueous phase, the extractability increased as the atomic number of the lanthanide increased. Equilibrium acid concentration was used as a parameter for the equilibrium curves. The general shape of these curves changed as the aqueous acid concentration increased from 1.4 M to 5.0 M HCl. The separation factor of Dy with respect to Gd, $\beta_{Dy,Gd}$, was also obtained in acidic chloride solutions. The total lanthanide chloride concentration, the total acidity, and the molar ratio of $GdCl_3$ to $DyCl_3$ in the equilibrium aqueous phase had only slight effect on the separation factor. The separation factor was in the range of 9 to 13 for the conditions studied. It was found that Yb and Lu were not removed from the organic phase by stripping four times with double volumes of 6 M HCl and other methods of back-extracting which have been previously used. A 20% hydrofluoric acid solution, however, completely removed the solute from the organic phase as the insoluble fluoride. (auth) (UK)

**45158** CONCENTRATION OF THE LITHIUM ISOTOPE BY MEANS OF THE HAEFFNER EFFECT. Maschka, A.; Bauer, G. Allg. Prakt. Chem., 18: 202-7(July 1967). (In German).

The influence of the amount of electricity, current density, and temperature on the concentration of Li isotopes by the Haeffner effect was investigated. Concentration studies at current densities of 4000 to 6000 $A/cm^2$ and temperatures of between 300 and 400°C showed that the separation effect increased with increasing current density. With increasing amounts of electricity a stationary condition with regard to concentration occurred. The influence of temperature was not accurately determined. (B.L.M.)

composite oxide with 25% plutonium, the volatilization of the uranium stops at 90% at temperatures of 250 and 300°C, but is complete at 350°C. With regard to the uranium volatilization rate, an anomaly was found, these rates being higher for the composite oxides than for the pure uranium dioxide. In contradiction with those of earlier tests, these results seem to be due to the special state (presence of impurities, structures, etc...) of the material used. Construction of the different appliances which will constitute the fuel assembly treatment unit is continuing. Chemical decanning tests were carried out on sub-assemblies of 19 elements 50 cm long in a column 10 cm in diameter. Complete decanning and total pulverization of the uranium dioxide pellets were obtained on this scale in the absence of alumina. With alumina present, agglomerates were formed. Analyses of the residua of these reactions are in progress. Variance analysis applied to the chlorine trifluoride reaction, on uranium dioxide pellets with fissium to determine the importance of the different parameters was continued. In addition, the influence of the temperature between 300 and 500°C on the volatilization rate and the fluoride utilisation efficiency of this reaction were examined. The rate and efficiency varied little between 300 and 500°C. But, as from 450°C, solidification between the pellets and the alumina occurred. A study on samples of an alumina-uranium tetrafluoride mixture was effected with a view to developing a sampling procedure making it possible, by means of a small number of analyses, to determine the total quantity of uranium or plutonium retained, by filtration, in the fixed alumina bed situated immediately after the volatilization reactor. In hot technology, the assembling of the hot thermobalance and the storage cell, the transforming and conditioning of the samples are continuing. Operating tests were carried out on the hot semi-pilot equipment. In the plutonium laboratory, two preliminary fluorination tests were effected on uranium dioxide pellets with 2% of plutonium dioxide by chlorine trifluoride. The mechanical decanning study and the health physics calculations are continuing. (auth)

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Thesis.

In attempts to find a correlation, drop size data were analyzed for several operating conditions and four liquid systems in a sinusoidally pulsed column. The variables investigated were plate hole diameter, per cent free area, frequency and amplitude of pulse, and the physical properties of the two liquids. The following equation was suggested by dimensional analysis: $D_D/D_N = 1.3036\ Pf^{0.05515}Bo^{-0.2045}M^{-0.32854}$. This equation predicted the 144 measured drop diameters with an average deviation of 8.3%. (auth)

**45143** (K-1734) NUCLEAR SAFETY STUDIES FOR LOW-ENRICHMENT FLUORIDE VOLATILITY FUEL REPROCESSING PLANTS. Habiger, K. E.; Breton, D. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 4, 1968. Contract W-7405-eng-26. 66p. Dep. CFSTI.

Conceptual and hardware development studies are being made relative to the design of fluoride volatility fuel reprocessing plants for low-enrichment nuclear reactor fuels. As a part of this effort, criticality calculations were made to establish reactivities of various assemblies of uranium and plutonium with other volatility process materials. These results were then used as bases for estimating the geometry or fissile mass limitations for the conceptual plant processing equipment. The DTF-II and ANISN one-dimensional $S_n$ multigroup transport codes were used in the $S_4$ option for the calculations. For uranium, calculations were made for cases involving homogeneous mixtures of uranium dioxide and alumina, uranium dioxide and water, uranium hexafluoride and hydrogen fluoride, and disodiumoctofluorouranate and sodium bifluoride. The maximum $^{235}U$ assay considered was 5%. Included in the plutonium studies were calculations for plutonium dioxide, plutonium hexafluoride, and plutonium tetrafluoride-sodium fluoride complex; calculations were also made for homogeneous mixtures of plutonium dioxide and water, plutonium dioxide and alumina, plutonium hexafluoride and hydrogen fluoride, and plutonium tetrafluoride-sodium fluoride complex and sodium bifluoride. Various geometries, including cylinders, spheres, and slabs were considered. In the plutonium studies, all plutonium was assumed to be $^{239}Pu$ except in one calculation series where a plutonium isotopic distribution similar to that expected in spent light water reactor fuel was considered. It was concluded that, based on the assumptions made, it should be possible to design most of the equipment in a volatility plant to be geometrically safe for uranium and plutonium, provided water is excluded from the process vessels. Mass control for plutonium might be necessary in large vessels, however, if the possibility of plutonium segregation is allowed. (auth)

**45144** (K-1745) ENGINEERING DEVELOPMENT OF AN ABSORPTION PROCESS FOR THE CONCENTRATION AND COLLECTION OF KRYPTON AND XENON. Second Summary Progress Report, July-December 1967. Merriman, J. R.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 19, 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

One of the most direct methods for stripping krypton and xenon from contaminated gas streams is selective absorption in a fluorocarbon solvent, such as refrigerant-12. A development program is under way to establish engineering scale-up data required for design of plants using the absorption technique for processing gases containing radioactive krypton and xenon isotopes. The scope of the work includes pilot plant testing, conceptual design studies for various plant-scale applications of the processes, and optimization studies. During this report period, construction and procurement of the pilot plant equipment items were essentially completed, and installation was begun. The conceptual design effort was temporarily reduced pending collection of pilot plant data to guide the selection of promising plant operating conditions. The basic material balance model used in the optimization work has been constructed, programmed, and tested; and equipment sizing and costing routines are currently being developed for incorporation into the material balance code. (auth)

**45145** (K-1754) A STUDY OF POLLUTANT DISCHARGES FROM REACTOR OPERATIONS UTILIZING ULTRACENTRIFUGATION TECHNIQUES. Amburgey, J. W. Jr. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 19, 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

Reactor cooling water samples from the Hanford Operation at Richland, Washington, have undergone particulate separations and study utilizing recently developed ultracentrifugation techniques. The suspended particles contained in these samples were separated into classified groups and then subjected to a variety of analytical investigations including elemental and radiochemical analyses. The samples selected for study were taken in sets ranging from one to four samples per set. Six sets or a total of sixteen samples were collected and shipped to the Biophysical Limnology Laboratory at Oak Ridge for study. The analytical results from these investigations are summarized in a series of tables. The content of selected elements and the radioactivity for the more prominent radionuclides are shown as associated with either the particulate or the dissolved fractions contained in the original sample volume. A few radionuclide parent elements such as chromium, sulfur, and zinc were found almost entirely associated with the dissolved materials fraction. These results along with other data showed that the suspended materials isolated from the various samples of reactor cooling water did not add significantly to the production of radionuclides and the radioactive pollution of the Columbia River at Hanford. (auth)

**45146** (NP-17588) THIRD REPORT ON THE ACTIVITIES OF THE EUROCHEMIC COMPANY, 1964-1966. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). 218p. Dep.

Research progress is reported under the following headings: safety at Eurochemic, hot cells, Janus cell assembly, head-end processes, pilot equipment, pilot-scale decanning, pilot-scale dissolution, U-Mo fuel element dissolution, Citriflex process for Zircaloy decanning, miscellaneous studies, extraction-evaporation pilot plant, highly enriched uranium fuel reprocessing, uranium(IV) nitrate as reducing agent for plutonium, electrolytic preparation of uranium(IV) nitrate, stability of uranium(IV) solutions, uranium-plutonium separation, final purification of plutonium, direct precipitation of plutonium oxalate, laboratory purification of plutonium from EL-1 fuel elements, final treatment of medium-level waste, solidification methods, treatment of waste from U-Mo alloy fuels, concentration of Zirflex waste, feasibility of high-level waste fixation in glass, analytical development, analytical methods for process control, development of analytical laboratory equipment, in-line instrumentation, second plant dissolver, plutonium tail-end, reprocessing of highly enriched uranium fuels, high-level waste storage, medium-level waste storage, low-level waste treatment, plant construction, commissioning the plant, first active test run, and plant operation. (M.C.G.)

**45147** (NYO-3462-4) STABLE ISOTOPE STUDIES. Annual Progress Report, July 15, 1967-August 15, 1968. Spindel, William (Yeshiva Univ., New York. Belfer Graduate School of Science). Contract AT(30-1)-3462. 29p. Dep. CFSTI.

Preliminary studies are reported on the dependence of the fractionation factor for nitrogen exchange in the $N_2O_3$-NO and $HNO_3$-NO systems as a function of temperature, pressure, and concentrations. These studies aim at an examination of the feasibility of using a dual-temperature process for nitrogen isotope

concentration. The temperature dependences of isotopic exchange equilibria of a number of oxynitrogen compounds were examined. "Anomalies" including inflections, maxima and minima, and "crossovers" in a plot of log K vs T were found to be fairly prevalent. The significance of the prevalence of temperature-dependence "anomalies" is discussed. Several approximation methods for predicting isotope effects were tested on the partition-function ratios of a number of oxynitrogen molecules and on the equilibrium constants for exchanges among them. The validity of the various approximation methods was critically examined. An improved method for using orthogonal polynomials for expansion of the reduced partition function ratio of isotopic molecules is described. Numerous model calculations indicate the effectiveness of this expansion technique. (auth)

**45148** (ORNL-tr-1785) THE CENTER AT LA HAGUE. Duboz, M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Energ. Nuc. (Paris), 7: 228-45(1965). 39p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 40273.

**45149** (RT/PROT-(68)8) TRANSIENT ANALYSIS FOR EXPLOSIVE PERTURBATIONS IN THE VENTILATION SYSTEM OF EUREX REPROCESSING PLANT. Perinetti, M.; Zaffiro, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 57p. Dep.

Transient phenomena occurring along the ventilation system of the EUREX reprocessing plant after an explosion in a process cell, were considered. Fundamental equations that describe the behavior of the plant during transient conditions are presented and a mathematical approach to solve them with the help of an analog computer was developed so that pessimistic results are obtained. Several analog runs were investigated and results are reported and discussed. The structural integrity of high-efficiency particulate filters was evaluated when considering the effects of abnormal conditions caused by explosions. An appendix was included to provide information on the analog circuit. (auth)

**45150** STATUS AND OUTLOOKS FOR THE REPROCESSING OF IRRADIATED FUELS IN SPAIN. Perez, B. Lopez; Jodra, L. G. pp 151-64 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Fuel reprocessing facilities, including the Hot Plant M-1, the CIES pilot plant, and the Hot Cell M-2, are described. Future outlooks on fuel reprocessing in Spain are considered along with financing. (M.C.G.)

**45151** DECONTAMINATION OF RADIOACTIVE EFFLUENT BY MEANS OF ZEOLITES. Verot, J.-L.; Blum, J. M. Energ. Nucl. (Paris), 10: 210-13(May 1968). (In French).

The decontamination of radioactive effluents by means of zeolites was studied using synthetic zeolytes and synthetic effluents in order to determine the best conditions for the fixation of $^{90}Sr$, $^{95}Zr$, $^{106}Ru$, $^{137}Cs$, and $^{144}Ce$, taken alone or in mixture. The results obtained are tabulated and show that this decontamination procedure is very efficient. Ce, Cs, Sr, and Zr and their decay products are eliminated under conditions so that their concentration is lowered to the vicinity of the maximum permissible concentration. The reduction factors obtained are approximately 3 to 5 times greater than those obtained during conventional treatment by coprecipitation. The results obtained for Ru are encouraging; there is at least one form of this element capable of being fixed by zeolites. (J.S.R.)

**45152** EXTRACTION OF AMERICIUM(III) AND EUROPIUM (III) BY DINONYLNAPTHALENE SULPHONIC ACID AND ITS SALTS. Khopkar, P. K.; Narayanankutty, P. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem., 30: 1957-62(Aug. 1968).

Equilibrium constants for the exchange of monovalent cations with hydrogen ions in dinonylnaphthalenesulfonic acid (HDNNS) dissolved in n-hexane and chloroform were determined at an ionic strength of unity. Extraction of Am(III) and Eu(III) from various acids and salt solutions containing the monovalent cations was studied with reference to the selectivity of $DNNS^-$ for these ions. (auth) (UK)

**45153** RADIOCHEMICAL PURIFICATION OF MICROGRAM AND SUB-MICROGRAM AMOUNTS OF BERYLLIUM. Piper, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Anal. Chim. Acta, 42: 423-9(Sept. 1968).

A method is presented for the separation and radiochemical purification of microgram and tracer amounts of beryllium from solutions. It is a four-stage ion-exchange procedure consisting of selective adsorption of the beryllium onto NaDAP resin and its elution with ammonium fluoride; adsorption of the fluoroberyllate complex onto an anion-exchange column and elution of the beryllium with hydrochloric acid; adsorption and selective elution of the beryllium on a cation-exchange column; a pass through an anion-exchange column in concentrated hydrochloric acid. The method is quantitative and requires no carrier. Decontamination factors from most radionuclides tested were greater than 10,000. The method can be used to determine $^{10}Be$ in environmental materials. (auth)

**45154** ACIDIC ORGANOPHOSPHORUS EXTRACTANTS. VI. EXTRACTION OF CALCIUM AND STRONTIUM BY DIOCTYL PHOSPHORIC ACIDS IN VARIOUS DILUENTS. Sistkova, N. V.; Kolarik, Z.; Barta, K.; Pankova, H. (Nuclear Research Inst., Rez, Czech.). J. Inorg. Nucl. Chem., 30: 1595-1603(July 1968).

The solvent extraction of Ca(II) and Sr(II) by di-n-octyl and bis(2-ethylhexyl) phosphoric acids was studied radiometrically. n-Heptane, cyclohexane, butyl ether, carbon tetrachloride, and toluene were used as diluents. The effect of extractant structure and diluent nature on the composition of Ca(II) and Sr(II) complexes in the organic phase as well as on the efficiency of Ca(II) and Sr(II) extraction and separation is discussed. (auth)

**45155** APPARATUS AND MATERIALS FOR HYPERPRESSURE GAS CHROMATOGRAPHY OF NONVOLATILE COMPOUNDS. Karayannis, Nicholas M.; Corwin, Alsoph H.; Baker, Earl W.; Klesper, Ernst; Walter, Joseph A. (Johns Hopkins Univ., Baltimore). Anal. Chem., 40: 1736-9(Sept. 1968).

A hyperpressure gas chromatograph was developed in order to extend studies on the development of gas chromatography under high pressures as an analytical or preparative method for nonvolatile organic, organometallic, and inorganic compounds. The suitability of various column packing materials is evaluated. Separations were achieved between various types of metalloporphyrins and between various metallic chelates of acetylacetone. (J.G.B.)

**45156** CHEMICAL STATE OF $^{125}I$ IN NEUTRON-IRRADIATED $XeF_2$ AND SEPARATION OF CARRIER-FREE $^{125}I$. Zaitsev, V. M.; Kirin, I. S.; Tikhonov, V. I. Radiokhimiya, 10: 391-3(1968). (In Russian).

The chemical state of $^{125}I$ ($T_{\frac{1}{2}}$ = 58 days and $E_\gamma$ = 35.5 keV) in neutron-irradiated xenon was studied. A method was developed for the separation of carrier-free $^{125}I$ from the irradiated $XeF_2$ according to the reaction $XeF_2 + 2\ NaOH \rightarrow Xe + \frac{1}{2}\ O_2 + 2\ NaF + H_2O$. (R.V.J.)

**45157** EXTRACTION OF SOME HEAVIER LANTHANIDES IN ACIDIC CHLORIDE SOLUTIONS BY DI(2-ETHYLHEXYL) PHOSPHORIC ACID. Owens, Thomas C.; Smutz, Morton (Iowa State Univ., Ames). J. Inorg. Nucl. Chem., 30: 1617-33(July 1968).

Equilibrium data were obtained for the systems $MCl_3$–HCl–$H_2O$–1 M D2EHPA (in Amsco Odorless Mineral Spirits), where M is used to designate the trivalent lanthanides Gd, Dy, Er, and Yb, over a wide concentration range of the lanthanide chloride in aqueous solution. For a particular acidity and a given lanthanide concentration in the aqueous phase, the extractability increased as the atomic number of the lanthanide increased. Equilibrium acid concentration was used as a parameter for the equilibrium curves. The general shape of these curves changed as the aqueous acid concentration increased from 1.4 M to 5.0 M HCl. The separation factor of Dy with respect to Gd, $\beta_{Dy,Gd}$, was also obtained in acidic chloride solutions. The total lanthanide chloride concentration, the total acidity, and the molar ratio of $GdCl_3$ to $DyCl_3$ in the equilibrium aqueous phase had only slight effect on the separation factor. The separation factor was in the range of 9 to 13 for the conditions studied. It was found that Yb and Lu were not removed from the organic phase by stripping four times with double volumes of 6 M HCl and other methods of back-extracting which have been previously used. A 20% hydrofluoric acid solution, however, completely removed the solute from the organic phase as the insoluble fluoride. (auth) (UK)

**45158** CONCENTRATION OF THE LITHIUM ISOTOPE BY MEANS OF THE HAEFFNER EFFECT. Maschka, A.; Bauer, G. Allg. Prakt. Chem., 18: 202-7(July 1967). (In German).

The influence of the amount of electricity, current density, and temperature on the concentration of Li isotopes by the Haeffner effect was investigated. Concentration studies at current densities of 4000 to 6000 $A/cm^2$ and temperatures of between 300 and 400°C showed that the separation effect increased with increasing current density. With increasing amounts of electricity a stationary condition with regard to concentration occurred. The influence of temperature was not accurately determined. (B.L.M.)

**45159** CONCENTRATION OF TRANSPLUTONIUM ACTINIDES FROM DIRT SAMPLES. Wolfsberg, Kurt; Daniels, William R. (to United States Atomic Energy Commission). U. S. Patent 3,395,992. Aug. 6, 1968.

A method is described for separating lanthanides and actinides produced in an underground nuclear detonation by extracting the lanthanides and actinides into tri-n-butyl phosphate, heavily salted with aluminum nitrate, further extracting into di-2-ethylhexyl orthophosphoric acid, esterifying this solution and passing it through an anion exchange resin column, and then separating the actinides from the lanthanides by eluting from a cation exchange resin column. (AEC)

**45160** EXTRACTION OF MOLYBDENUM(VI) WITH TRIBUTYL PHOSPHATE FROM HYDROCHLORIC ACID SOLUTION. Ezhovska-Tshebyatovska, B.; Kopach, S.; Bartetski, A. (Vrotslavskii Univ., USSR). Zh. Neorg. Khim., 13: 1899-1908(July 1968). (In Russian).

An investigation was made of the extraction of Mo(VI) with TBP solution in inert diluents from hydrochloric acid solutions. The optimum conditions for the separation of Mo in the vacuum pulsation column were determined. The solvate number for the Mo complex being extracted was determined; it was shown that it is equal to two and is not changed during variation of the test conditions. The absorption spectra of the organic and aqueous phases, containing Mo(VI), and also of the original molybdate aqueous solutions were determined. The data obtained were discussed. On the basis of the extraction data and the spectroscopic investigations, the mechanism for the extraction of Mo(VI) from HCl solutions with TBP was determined: it was shown that Mo is extracted by two equal mechanisms in dependence on the HCl concentration. (tr-auth)

**45161** METHOD FOR ISOLATING Pu AND U IN THE ALKYLAMINE–SULFURIC ACID SYSTEM. Akatsu, Jokun (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-15513. Aug. 26, 1967. Filed May 23, 1964.

An improved method of fractional separation of irradiated U, by solvent extraction, is proposed. Irradiated U is dissolved in dilute $H_2SO_4$, and it is oxidized with $H_2O_2$. The solution is then extracted with an alkylamine, leaving most fission products in the aqueous phase and taking up U, Pu, Zr, Nb, etc., into the organic phase. From this organic phase, Pu is back-extracted with an $H_2SO_3$ solution. Then, from the organic phase, Zr and Nb are back-extracted into the aqueous phase with sulfuric acid-acidified $NH_4C_2H_3O_2$ solution containing $H_2O_2$. Finally, Pu is back-extracted into the aqueous phase from the remaining organic phase with $NH_4C_2H_3O_2$ solution containing $H_2O_2$. (NSA of Japan)

**45162** METHOD FOR DIRECTLY RECOVERING Pu FROM SPENT URANIUM FUEL. Ishihara, Takehiko (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-15511. Aug. 26, 1967. Filed Feb. 10, 1964.

A method is proposed for the direct extraction of Pu from undissolved U fuel with an amine nitrate. The Pu is then recovered as a precipitate. Spent uranium fuel is oxidized and reduced repeatedly, to divide it into powder and to activate it. Then, the powder is again crushed in a ball mill to refresh the surface. A nitrate of an aliphatic tertiary amine having an alkyl chain is added, and the mixture is stirred. Then, the amine nitrate, containing Pu, is separated. Finally, Pu is precipitated in the aqueous phase with oxalic acid solution. (NSA of Japan)

**45163** SEPARATION OF URANIUM AND FISSION PRODUCT ELEMENTS BY EUTECTIC FREEZING OF URANYL NITRATE HEXAHYDRATE. Christensen, Hans Th.; Holmberg, Karl-Erik (Institut fuer Kernchemie Aktiebolaget Atomenergie, Studsvik, Sweden). Nukleonik, 11: 165-70(July 1968). (In German).

It was proved that uranium can be recovered from an aqueous fission product-containing uranyl nitrate solution by crystallization of $UO_2(NO_3)_2 \cdot 6H_2O$ at low temperatures. The product can be further purified by recrystallization. Ice crystallizes at the same time as the uranyl nitrate bringing about a reduction in volume. With a volume reduction of 85%, a uranium recovery of 88.5% is achieved. There is a limit to the volume reduction by this method due to the heat generated by the fission products in more concentrated amounts. The three-component system $UO_2(NO_3)_2-HNO_3-H_2O$ was investigated further at low temperatures and the eutectic temperature of the ternary mixture determined. (tr-auth)

**45164** SEPARATION OF BERYLLIUM AND ZIRCONIUM BY ELECTRODEPOSITION OF HYDROXIDES. Golubev, V. N.; Kovarskii, N. Ya. (Academy of Sciences, Vladivostok, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 4, 137-9 (Mar. 1968). (In Russian).

The possibility of the separation of beryllium and zirconium as solutions in nitric acid by electrochemical change of pH has been investigated. The process is best performed by shifting pH electrochemically to 5 in dilute solutions, where concentration of beryllium does not exceed that of zirconium; under these conditions zirconic acid (purity about 98 to 99%) is precipitated leaving a highly pure solution of the beryllium salt. (auth)

**45165** EXTRACTION OF THORIUM BY BENZHYDROXAMIC ACID. Rudenko, N. P.; Al Samari, A. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 44-7(May-June 1968). (In Russian).

The coefficient of distribution of benzohydroxamic acid (BHA) in the $CHCl_3-H_2O(P_{BHA} = 0.055 \pm 0.01)$ and $C_8H_{13}OH-H_2O(P_{BHA} = 2.07 \pm 0.01)$ systems was determined at 22°C and $\mu = 0.1$. The dissociation constant of BHA ($pK_{BHA} = 8.84$) was also obtained. The extraction of the Th complex with BHA by chloroform, 1-hexanol, methyl butyl ketone, and a mixture of 1-hexanol and chloroform was studied. (auth)

**45166** STUDY OF THE INTERACTION OF RADIOACTIVE MICROCOMPONENTS IN AQUEOUS SOLUTION WITH ALKYLARYLSULFONIC ACID BY THE FOAMING METHOD. II. EFFECT OF SALTS OF ALKALI AND ALKALINE EARTH ELEMENTS ON THE SORPTION OF $^{90}Sr$ AND $^{90}Y$ BY FOAM OF ALKYLARYLSULFONIC ACID. Pushkarev, V. V.; Berezyuk, V. G. Radiokhimiya, 10: 319-24(1968). (In Russian).

The effect of NaCl, LiCl, KCl, $NaNO_3$, $Na_2SO_4$, $CaCl_2$, $SrCl_2$, and $BaCl_2$ on the degree of extraction of $^{90}Sr$ and $^{90}Y$ isotopes with alkylarylsulfonic acid at the boundary line of the air–solution phase using the foam formation method was investigated. The dependence of the logarithm of separation of the cations of the radioactive microcomponents between the foam and solution on the activity of the cation of the salt addition is described by equations appearing as a consequence of the effective mass law. (tr-auth)

**45167** SEPARATION OF TANTALUM AND HAFNIUM BY COPRECIPITATION WITH IRON HYDROXIDE. Novikov, A. I.; Zakrevskaya, T. M.; Ryazanova, G. K. Radiokhimiya, 10: 368-9(1968). (In Russian).

The coprecipitation of small quantities of $^{175}Hf$ and $^{182}Ta$ with iron hydroxide in 1M solution of $NH_4NO_3$ and 0.5M solution of $NH_4HCO_3$ was investigated as a function of the pH of the medium. The method for the separation of Hf and Ta by the coprecipitation of Ta with iron hydroxide in the medium studied was proposed in the pH range of 8 to 9. (tr-auth)

**45168** SEPARATION OF TANTALUM, TUNGSTEN, AND RHENIUM BY COPRECIPITATION WITH IRON HYDROXIDE. Novikov, A. I.; Ryazanova, G. K. Radiokhimiya, 10: 369-71 (1968). (In Russian).

The coprecipitation of small quantities of Ta, W, and Re, produced by nuclear reactions, with iron hydroxide was studied as a function of the pH of the medium. The separation of Ta, W, and Re was done by the successive coprecipitation of Ta and W with iron hydroxide at pH = 5 to 8, during which separation from Re occurred, and by coprecipitation of Ta at pH = 11 to 13 for the purpose of its separation from W. (tr-auth)

**45169** SEPARATION OF RUBIDIUM AND CESIUM BY THE METHOD OF FOCUSING ION EXCHANGE. Shvedov, V. P.; Fomin, V. V.; Kolin, V. V. Radiokhimiya, 10: 371-3(1968). (In Russian).

The possibility of the carrier-free separation of $^{86}Rb$ and $^{134}Cs$ by the method of focusing ion exchange was investigated. It was established that the optimum conditions for the separation of mixtures of $^{86}Rb$ and $^{134}Cs$ are: catholyte – 0.01M $K_4[Fe(CN)_6]$; anolyte – 0.2M $CaCl_2$; separation time of 6 min; potential gradient of 25 V/cm. The distance between zones is 32 mm in this case. It was found that a mixture of K, Rb, and Cs ions with the ratio K : (Rb + Cs) = 80 : 1 can be separated with satisfactorily distinct zones. (tr-auth)

**45170** INVESTIGATION OF SOME ION-EXCHANGE PROPERTIES OF ALGINIC ACID AND ITS INTERACTION WITH BI- AND TRIVALENT CATIONS. Dolmatova, M. Yu.; Panteleeva, A. P. Radiokhimiya, 10: 379-82(1968). (In Russian).

The dissociation constant of alginic acid was determined as $K = 2.2 \times 10^{-4}$ by the method of potentiometric titration. The separation coefficients of a series of bi- and trivalent elements on alginic acid were determined under static conditions. The elements studied can be arranged in the following order with respect to their sorption on alginic acid: $Pb^{2+} > Cu^{2+} > Ba^{2+} > Sr^{2+} > Ca^{2+} > Cd^{2+}$, $Co^{2+} > Ni^{2+}$, $Mn^{2+}$, $Zn^{2+}$ and $Fe^{3+} > Ce^{3+} > Y^{3+}$. In the alkaline earth group of elements, the sorption is decreased from Ba to Ca corresponding to the increase of the radius of the hydrated ion. (tr-auth)

**45171** SEPARATION OF SULFUR AND PHOSPHORUS BY COPRECIPITATION OF PHOSPHATE IONS WITH IRON HY-

DROXIDE. Novikov, A. I.; Shchekoturova, E. K. Radiokhimiya, 10: 366-7(1968). (In Russian).

A method for the separation of small quantities of labeled sulfate and phosphate ions by the coprecipitation of the phosphate ions with iron hydroxide was developed. (tr-auth)

**45172** SPECTROPHOTOMETRIC STUDY OF CONDITIONS FOR EXTRACTION OF TITANIUM, NIOBIUM, AND MOLYBDENUM COMPLEXES WITH SALICYLHYDROXAMIC ACID. Borzenkova, N. P. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 84-8(May-June 1968). (In German).

Titanium, niobium, and molybdenum complexes with salicylohydroxamic acid were shown to be extracted by some alcohols and ketones. Titanium complex was extracted by cyclohexanone from solution at pH = 0 to 3 almost completely. The maximal absorption of extract was found to be at 367 mμ. The molar extinction coefficient was found to be $1 \times 10^4$. Molybdenum complex was extracted at pH = 4 to 6 (25%). Niobium complex was extracted from 4 to 6 M $H_2SO_4$ solution (70%). Molybdenum in the form of anion associated with organic cations can be extracted by chloroform. (auth)

**45173** CALCULATION AND RESULTS OF ALKALI METAL SEPARATION ON DEXTRAN GEL COLUMNS. Ortner, H.; Spitzy, H. (Technische Hochschule, Graz). Z. Anal. Chem., 238: 251-67(1968). (In German).

The mathematical treatment of the procedure for separation of alkalis on Sephadex G-25 columns with 75% (v/v) methanol as eluant is presented. From a short confrontation of the different chromatographic theories it follows that the plate theory is best suited for a ready estimation of proper column dimensions. At near-equilibrium conditions the system in question can actually serve as model for such calculations because of linear partition isotherms even at nontrace conditions. At distinct nonequilibrium conditions the construction of elution profiles is still feasible by a prompt estimation of characteristic points of the elution curves. In the second part of the paper, the alkali separation possibilities at optimal conditions are shown which resulted from the investigation of influencing parameters and the calculation of proper column dimensions. This separation procedure is critically compared to other modern possibilities of alkali separation. (auth)

**45174** EXTRACTION OF COMPLEX COMPOUNDS OF NEPTUNIUM WITH 1-PHENYL-3-METHYL-4-BENZOYL-5-PARAZOLONE. Moseev, L. I.; Monakhov, B. V. Radiokhimiya, 10: 309-14(1968). (In Russian).

The extraction of neptunium(IV) with 1-phenyl-3-methyl-4-benzoyl-5-pyrazolone (PMBP), indexed as 4-benzoyl-3-methyl-1-phenyl-2-pyrazolin-5-one, from solutions of nitric, hydrochloric, sulfuric, and perchloric acids was investigated. It was found that Np(IV) in the quantity of $\sim 10^{-4}$ M was almost completely extracted with a 0.05 M solution of the reagent in benzene from 1 to 4 M nitric acid and 1 to 6 M hydrochloric acid, whereas from sulfuric and perchloric acid solutions the extraction was somewhat less. The extraction of Np(IV) was not impeded by 0.5 g-ion/l oxalate ions, 2 g-ion/l acetate ions, 1 g-ion/l citrate ions, and 1 g-ion/l phosphate ions. The extraction of Np(IV) with the pyrazolone depends on the type of solvent and the reagent concentration. The maximum extraction of Np(IV) was observed in solutions of PMBP in isoamyl alcohol, n-amyl acetate, and especially mixtures of isoamyl alcohol with isoamyl acetate. It was established that ions of Np(V) and Np(VI) are not extracted under conditions of optimum extraction of Np(IV). (tr-auth)

**45175** TECHNOLOGICAL EXTRACTION OF TANTALUM AND NIOBIUM FROM THE INTERMEDIATE PRODUCTS OF TIN–TUNGSTEN PRODUCTION. Chernyak, A. S.; Mineev, G. G.; Kleshchenko, N. S.; Yakovlev, M. A.; Druzhina, G. Ya.; Korytin, M. I.; Sherstov, V. Ya. Tsvetn. Metal., No. 6, 70-1(June 1968). (In Russian).

The procedure is based on the sulfate peroxide reprocessing of the intermediate products using low-temperature sulfating and the leaching of the sulfate mass with solutions containing two complexing reagents: hydrogen peroxide and a fluoride, which makes it possible to reduce the consumption of the basic reagents and to increase the economy of the process. Processes for the extraction of Sc, W, and Sn were developed. (tr-auth)

**45176** THIN-LAYER CHROMATOGRAPHIC SEPARATION OF SCANDIUM, YTTRIUM, THE RARE EARTHS, THORIUM AND URANIUM(VI). Oguma, Koichi (Government Chemical Industrial Research Inst., Tokyo). Talanta, 15: 860-4(Aug. 1968).

The chromatographic behavior of scandium, yttrium, the rare earths, thorium, and uranium(VI) in dioxan–hydrochloric acid and dioxan–nitric acid media on a plain cellulose thin layer was investigated. The following separations are possible: scandium–yttrium–lanthanum, scandium–samarium–thorium, scandium–lanthanum–lutetium, yttrium–lanthanum–thorium, and lutetium–thorium–uranium(VI) with dioxan–12M hydrochloric acid (7:3); and scandium–samarium–thorium, scandium–yttrium–uranium (VI), lutetium–thorium, and scandium–lanthanum–thorium with dioxan–14 M nitric acid (7:3). A single chromogenic spray (Arsenazo III) was used for the detection of all the metal ions studied. (auth) (UK)

# EARTH SCIENCES

## Geology and Hydrology

*Refer also to abstracts 45145, 45183, 45199, 45345, and 45548.*

**45177** (BNWL-SA-1152) MATHEMATICAL MODEL FOR UNDERGROUND DISCHARGE OF RADIOACTIVE GASES. King, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 27, 1967. Contract AT(45-1)-1830. 21p. Dep. CFSTI.

Mathematical models were developed for injection of gas into the partially saturated zone above the water table. For the present capability of solving differential equations, one model is used during injection and a different model is used after cessation of injection. Assumptions made for the model were: the gas obeys Darcy's equation, soil moisture is immobile, flow is isothermal and steady, soil is homogeneous and isotropic, soil moisture content is uniform, equation of state for dry air is sufficient to describe the gas, the gas is compressible, and the system is symmetric about the axis of the injection well. Comparisons of calculated and measured values were satisfactory. (M.C.G.)

**45178** (DPST-68-30-2) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, January–June 1968. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Contract AT(07-2)-1. 18p. Dep. CFSTI.

The results of an environmental monitoring program for the atmosphere, vegetation, milk, and water, conducted between January 1 and June 30, 1968, at the Savannah River Plant, are presented. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by fallout from offsite sources. Beta activity in air, which showed no correlation with plant operations, was about the same as that observed for the same period for 1967 and was a fivefold increase over the previous six month period. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of any radionuclide in river water at Highway 301 did not exceed 0.3% of the Maximum Permissible Concentration. (auth)

**45179** (NSJ-tr-119) STUDY OF AGE DATING BY $^{176}Lu$–$^{176}Hf$ METHOD. I. ON THE SEPARATION OF Zr AND Hf. Shima, Makoto; Amano, Sadayo. Translated from Rika Gaku Kenkyusho Hokoku, 42: No. 3, 133-6(1966). 9p. Dep.

For determination of geological ages, various methods have been developed, including potassium–argon, rubidium–strontium, and lead. By way of eliminating the draw-backs to these methods, the Lu–Hf technique was studied. It utilizes the decay of $^{176}Lu$ to $^{176}Hf$ and can be applied for dating of minerals containing Lu and Hf. In this method, it is necessary to separate chemically zirconium and hafnium, to determine hafnium and lutetium and to measure $^{176}Hf$ by a mass-spectrometer. The methods for separation of zirconium and hafnium were investigated. Among the two solvent extraction methods (TBP-hydrochloric acid or TBP-nitric acid system, and TTA-perchloric acid system) and two ion exchange methods (using Dowex-50 and Amberlite IRA-400, respectively), it was found that the ion exchange method using Dowex-50 can separate hafnium so as to be satisfactorily used for the mass-spectrometry. (auth)

**45180** (ORO-3622-2) ABSOLUTE DATING OF OCEAN SEDIMENTS BY USE OF $^{230}Th/^{231}Pa$ RATIO AND GEOCHEMICAL STUDIES OF LIMITING BOUNDARY CONDITIONS WITH SPECIAL ATTENTION TO EXOTIC ENVIRONMENTS. Progress Report. Rona, Elizabeth (Miami Univ., Fla. Inst. of Marine Science). Aug. 1968. Contract AT(40-1)-3622. 10p. Dep. CFSTI.

Results are given for the absolute dating of lake and ocean sediments using the $^{230}Th/^{231}Pa$ method. The sediment core samples included two from the central Caribbean, one from the southwestern Pacific, and two from lakes in southern Norway. The ages obtained for the Caribbean cores are in agreement with ages obtained from other deep sea cores from the same area. The error in age values was reduced to less than 5% with the $^{230}Th/^{231}Pa$ method. The $^{230}Th/^{231}Pa$ ratios obtained from layers of the Pacific core varied greatly and were not distributed in a stratigraphic order. It is believed that the opal content of the sediments caused fractionation of the $^{231}Pa$ and $^{230}Th$, and further mineralogical studies on this are recommended. $^{230}Th/^{231}Pa$ dating of the lake cores did not establish an age gradient through the cores, which indicates that the sediments were all deposited during the postglacial time. (L.C.L.)

**45181** RADIOACTIVITY WITHIN A TUNNEL IN GRANITIC ROCK. Lloyd, R. D.; Pendleton, R. C.; Downard, T. R. (Univ. of Utah, Salt Lake City). Health Phys., 15: 274-6(Sept. 1968).

Radiological surveys of a microfilm records storage facility located in Little Cottonwood Canyon, southeast of Salt Lake City, are reported. (UK)

**45182** CHEMICAL AND ISOTOPIC BALANCES FOR A MEROMICTIC LAKE. Takahashi, Taro; Broecker, Wallace; Li, Yuan Hui; Thurber, David (Columbia Univ., Palisades, N. Y.). Limnol. Oceanogr., 13: 272-92(Apr. 1968).

A chemical and isotopic study of the waters and sediments of Fayetteville, New York, Green Lake has allowed the cause of its meromixis to be defined. Stagnation is clearly the result of two different water types entering the lake. Water entering below the chemocline is almost twice as saline as that entering the surface layer. This conclusion is based on hydrologic, isotopic, and chemical balances. For carbon and its isotopes, the contributions of $CaCO_3$ precipitation, of the photosynthetic cycle, of gas exchange with the atmosphere, and of hydrologic transport are considered. Our results indicate a mean residence time of two years for surface water and of 4 to 30 years for deep water. The water entering the deep reservoir must be richer in $Na^+ + K^+ + Cl^-$ relative to $Mg^{2+} + Ca^{2+} + HCO_3^- + SO_4^{2-}$ than that entering the surface reservoir. Its carbon must also be more deficient in $^{13}C$ and $^{14}C$ and its degree of supersaturation with respect to calcite lower than surface water. Although both reservoirs are supersaturated with calcite, the carbon isotope data clearly indicate that precipitation takes place largely from the surface water. (auth)

## Meteorology

*Refer also to abstracts 45139, 45178, 45226, 45331, and 45356.*

**45183** (MLM-1522) ENVIRONMENTAL MONITORING REPORT: JANUARY–JUNE 1968. Anderson, H. F.; Sheehan, W. E. (Mound Lab., Miamisburg, Ohio). Aug. 27, 1968. Contract AT-(33-1)-Gen-53. 41p. Dep. CFSTI.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, is presented for the first half of 1968. The average concentration of radionuclides from Mound Laboratory in the Great Miami River and in the environmental air was within the stringent standards of safety specified by the Atomic Energy Commission. (auth)

**45184** (NP-17555) ENVIRONMENTAL CONTAMINATION BY RADIOACTIVE SUBSTANCES. (Environmental Radiation Exposure Advisory Committee). Dec. 1, 1967. 24p. GPO.

A nationwide surveillance to measure the levels of radioactive contamination of air, water, and food is needed. The findings of Environmental Radiation Exposure Advisory Committee are presented regarding current sources of contamination, and amounts of contamination likely to occur in the future resulting from the use of atomic energy. Guidelines are enumerated. The principal characteristics of 10 radionuclides are summarized. (J.C.W.)

**45185** (NYO-3756-2) FUNDAMENTAL STUDIES IN FALLOUT FORMATION PROCESSES. Progress Report, June 1, 1967–May 31, 1968. Russell, Irving J. (Boston Coll., Chestnut Hill, Mass.). June 1, 1968. Contract AT(30-1)-3756. 98p. Dep. CFSTI.

Progress is reported on exploding-wire and sealed-chamber techniques for investigation of fallout formation processes. Topics covered include: nuclear debris formation, exploding-wire studies of trace element fractionation, nucleation processes, sealed-chamber determination of relative uptake factors for trace vapor levels in contact with oxide melts, and environmental studies using high-resolution gamma spectroscopy. Separate abstracts were prepared for each of the 5 sections. (M.C.G.)

*For abstracts of individual sections see: 44980 and 45186–45189.*

**45186** (NYO-3756-2, Sect. B) REVIEW OF CONCEPTS AND MODELS CONCERNING NUCLEAR DEBRIS FORMATION. 15p.

Various fallout models are reviewed, including particle activity models. It is suggested that a satisfactory physical model of debris formation must include due consideration of vaporization, condensation, and agglomerative processes. The following debris formation processes are postulated: condensation of primary soil vapors and coagulation to a distribution of primary spheres, impact and sticking of primary droplets on secondary molten drop-

lets of melted but not volatilized soil, coagulation of molten droplets to larger aggregates, condensation of volatile element vapors as temperature falls. Partial pressures of condensing species in land-surface nuclear explosions are discussed. The cooling rate of the nuclear cloud is considered. (M.C.G.)

**45187** (NYO-3756-2, Sect. C) EXPLODING WIRE STUDIES OF TRACE ELEMENT FRACTIONATION. Driscoll, Joseph R.; Russell, Irving J. 34p.

Equipment, sample preparation, collection, and product analysis for trace element fractionation studies are discussed. Radioisotopes were used as tracers in the studies. The Boston College Exploding Wire Facility is described. (M.C.G.)

**45188** (NYO-3756-2, Sect. D) BRIEF REVIEW OF NUCLEATION PROCESSES. Lin, Jeong-long. 11p.

The kinetics of gas-phase condensation are reviewed. The classical theory of nucleation and the statistical mechanical theory of nucleation are discussed. Application of the nucleation theory to the exploding wire experiment is considered. (M.C.G.)

**45189** (NYO-3756-2, Sect. F) INVESTIGATION OF A SEALED CHAMBER TECHNIQUE FOR THE DETERMINATION OF RELATIVE UPTAKE FACTOR FOR TRACE VAPOR LEVELS OF ELEMENTS IN CONTACT WITH OXIDE MELTS. Carmon, B.; Russell, I. J. 19p.

Work was undertaken to provide a set of relative absorption constants for trace fission products in oxide melts of various compositions over a range of temperatures from about 1000 to 1600°C. The design and testing of a quasi-isopiestic technique for this purpose are described. Data from tracer studies were analyzed in terms of 3 processes: diffusion from the vapor phase to the surface of the particle, reaction at the surface of the particle, and diffusion from the surface to the interior of the particle. It is shown that substrate effects can be large. The relative uptake by two substrates of a given vapor can be reversed as a function of temperature. Reverse heating experiments indicated a high degree of irreversibility and perhaps a two-step diffusion loss process. (M.C.G.)

**45190** (TID-24190) METEOROLOGY AND ATOMIC ENERGY, 1968. Slade, David H. (ed.) (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.). July 1968. 445p. Dep. CFSTI.

Discussions on meteorology in relation to the atomic energy industry are presented. A separate abstract was prepared for each of the eight chapters of the report. (L.C.L.)

*For abstracts of individual papers see: 45191–45197 and 45356.*

**45191** (TID-24190, pp 1-12) INTRODUCTION TO THE METEOROLOGY–ATOMIC ENERGY RELATION.

The history of air pollution meteorology which deals with all types of releases of material to the atmosphere is discussed briefly. The specific role of the meteorologist in association with the atomic energy industry is defined, the historical development of this role as the atomic energy industry progressed is reviewed, and improvements in meteorological methods and equipment are outlined. (L.C.L.)

**45192** (TID-24190, pp 13-63) METEOROLOGICAL FUNDAMENTALS FOR ATMOSPHERIC TRANSPORT AND DIFFUSION STUDIES.

Basic physical atmospheric processes are described to acquaint the non-meteorologist with meteorological concepts and terminology. Climatology and conventional weather data are discussed, followed by the fundamental concepts related to atmospheric transport and diffusion studies. (L.C.L.)

**45193** (TID-24190, pp 65-116) AN OUTLINE OF THEORIES OF DIFFUSION IN THE LOWER LAYERS OF THE ATMOSPHERE. Gifford, Franklin A. Jr. (Environmental Science Services Administration, Oak Ridge, Tenn.).

A mathematical-physical model is developed for describing the role of the earth's lower atmosphere in redistributing and diluting pollutants introduced into the atmosphere. The pollutants may be conventional or radioactive. The source of pollution considered may be either continuously emitting, such as power plant stacks, or quasi-instantaneous, such as a nuclear rocket launch-pad accident. The principal theories of atmospheric diffusion are mentioned, fundamentals of fluid flow as they apply to conditions in the earth's boundary layer are discussed, and mathematical formulas for describing atmospheric diffusion are derived. (L.C.L.)

**45194** (TID-24190, pp 117-88) DIFFUSION AND TRANSPORT EXPERIMENTS. Islitzer, Norman F. (Environmental Science Services Administration, Idaho Falls, Idaho); Slade, David H.

The relationship between measured meteorological data and atmospheric diffusion is illustrated, and a set of diffusion parameters that can be estimated from meteorological observations at a given site is established. Primary attention is given to the turbulent diffusion of gases and aerosols. Numerous diffusion experiments, performed at many locations and covering a broad range of meteorological data, are reviewed and compared. (L.C.L.)

**45195** (TID-24190, pp 189-255) PROCESSES OTHER THAN NATURAL TURBULENCE AFFECTING EFFLUENT CONCENTRATIONS. Briggs, Gary A. (Environmental Science Services Administration, Oak Ridge, Tenn.); Van der Hoven, Isaac; Engelmann, Rudolf J.; Halitsky, James.

An investigation was made of the significance of processes, other than natural atmospheric turbulent diffusion, that affect the transport and diffusion of radioactive material emitted into the atmosphere. These processes include: momentum and buoyancy due to mode of transmission; surface deposition of airborne material and factors such as gravitational settling, precipitation scavenging, chemical interaction, etc., which influence the surface deposition; and the effect on the effluent flow of buildings and ground contours near the source. Each process is described, theoretical relations are developed, and experimental data presented. (L.C.L.)

**45196** (TID-24190, pp 301-77) RADIOACTIVE CLOUD-DOSE CALCULATIONS. Healy, John W. (General Electric Co., Schenectady, N. Y.); Baker, Robert E.

Techniques of radiation-dosage calculations are presented considering only dosages which would result from the release of radioactive material to the atmosphere and which would be received by living matter or inert objects. The major elements required for radiation-dosage calculations are given. These elements include the characteristics of radioactive materials, the nature of fission product wastes from the nuclear industry, radiological considerations of $\alpha$, $\beta$, and $\gamma$ radiation from different sources, and the effect of meteorological and shielding conditions on the dosages received. Graphical and tabular data are included. (L.C.L.)

**45197** (TID-24190, pp 379-99) ENVIRONMENTAL SAFETY ANALYSIS. Fuquay, James J. (Battelle-Northwest, Richland, Wash.).

A safety analysis for determining environmental effects of airborne effluents from nuclear plants is presented. Three time conditions for effluent release are included: instantaneous (accidental), intermediate length, and long-period. Equations, tables, and graphic representations of results for various meteorological and effluent conditions are given. (L.C.L.)

**45198** ON DRY FALLOUT PRODUCTS FROM NUCLEAR TESTS. Shem'i-zade, A. E. At. Energy, (USSR), 24: 474-5 (May 1968). (In Russian).

Studies of dry fallout from nuclear tests in the Uzbekistan region showed that the ratio of moist fallout $C_m$ and dry $C_d$ measured in Denmark and England was not suitable for the dry Uzbekistan climate. The mean quantity of dry fallout in Tashkent during global fallout was 74 ± 20% and during intense fallout 42 ± 25%. Moreover, at some special intervals the ratio of dry fallout was as high as 96%. (R.V.J.)

**45199** FIELD EXPERIENCE IN CONCENTRATION OF ISOTOPES FROM WATER. Berestovskii, F. G. Gig. Sanit., No. 2, 112-14(Feb. 1968). (In Russian).

A simple portable kit is described for collecting concentrated radioisotopes from drinking water samples and atmospheric precipitation. Experiments with 103 specimens of drinking water and 35 specimens of atmospheric precipitation absorbed on the surface of pure sulfocarbons acting as cation exchange resin confirmed the efficiency of the kit. (R.V.J.)

## Mineralogy and Exploration

**45200** (NSJ-tr-110) URANIUM RESOURCES OF JAPAN. THE PRESENT STATE OF PROSPECTING AND DEVELOPMENT, AND THE FUTURE ASPECT. Sato, Motoo. Translated from Nippon No Kagaku To Gijutsu, 6: No. 12, 6-13(1965). 15p. Dep.

This report was abstracted from the original language and appeared in NSA as 21: 3195. (R.C.K.)

**45201** CONCENTRATION OF URANIUM MINERALS IN THE REPUBLIC OF NIGER AND THE CENTRAL-AFRICAN REPUBLIC. Renaud, Jean Energ. Nucl. (Paris), 10: 150-1(May 1968). (In French).

The ore deposits of Niger are characterized by the presence, in variable proportions in the mineralized zone, of clear sandstone with the uranium in the form of classic mineral species and very friable clays of dark gray almost black color with the uranium found very diffused. The ores of the Central-African Republic are quite different. They are very heterogeneous with

the presence of a high proportion of phosphate minerals as the dominant character. The preliminary studies on the chemical attack of these ores are indicated. For the Niger ores, high concentrations of sulfuric acid were used to attack the ground ores. For the ores of the Central-African Republic a solution of sulfur dioxide as concentrated as possible was used as the attacking reagent. (J.S.R.)

**45202** GEOLOGY OF ECONOMIC URANIFEROUS PEGMATITES IN THE BANCROFT AREA, ONTARIO. Cunningham-Dunlop, Peter K. Princeton, N. J., Princeton Univ., 1967. 290p. Thesis.

The uranium mining district is within the Hastings-Haliburton Highlands, near their boundary with the Hastings Basin. It is concluded from the chemical composition of garnet-sillimanite-biotite-quartz feldspar paragneiss, calculated from optical and modal data and compared with analyses of Precambrian shales, that this member originated as an iron-rich pelite, with a moderately high Al and low K content. Other gneisses at Bicroft and Canadian Dyno represent greywacke, limy shale, and shaly limestone. Small metadiorite dykes are probably related to the Faraday metagabbro, the oldest intrusive rock in the region. On the basis of the existing mineral assemblages encountered in metasediments, metadiorite, and metagabbro, regional metamorphism was of the Barrovian type, and reached upper almandine-amphibolite and lower granulite facies conditions. Quartz-sillimanite-biotite-almandine-plagioclase-(K-feldspar) is shown by graphic analysis of phase relationships to represent a possible equilibrium assemblage. Sillimanite was probably produced isochemically by the reaction staurolite + quartz → sillimanite + garnet. The K-feldspar may have been derived from musocovite. It is suggested that the temperature of regional metamorphism was 700 ± 100°C, $P_{TOTAL}$ was 3Kb ± 2Kb, and $P_{H_2O}$ was less than $P_{TOTAL}$ but greater than 1Kb. Detailed studies of distribution trends among mineralogic, lithologic, and structural features lead to the conclusion that despite their obvious restriction to pegmatite bodies, uranium minerals do not represent generally the products of crystallization in a closed pegmatite system, but represent epigenetic and late-stage additions to fractured and chemically favorable pegmatites. The ore minerals uraninite and uranothorite occur almost exclusively in quartz, with abundant zircon, sphene, and allanite, and varying amounts of magnetite, fluorite, pyrite, and uncommon radioactive minerals. Ore shoots are concentrated, along dyke margins, adjacent to inclusions, in zones near internal fractures, and with pyroxene, hornblende, and biotite. Ore and accessory mineral elements may have been derived from sedimentary rocks of littoral or protopelitic origin situated in or below the Grenville series. X-ray studies of Bicroft uranothorites indicate a decrease in U content with possible falling temperature in successive stages of dyke development. Autoradiograph investigations illustrate a close association of ore and accessory minerals with Fe-bearing minerals. (Disser. Abstr.)

**45203** EFFECT OF OXIDATION PROCESSES ON THE SEPARATION OF ISOTOPES OF URANIUM DURING THEIR LEACHING FROM MINERALS. Chalov, P. I.; Merkulova, K. I. (Inst. of Physics and Mathematics, Frynze, USSR). Geokhimiya, No. 7, 872-6(July 1968). (In Russian).

The results obtained during study of the isotopic ratio $^{234}U/^{238}U$ in composite uranium, valence fractions (extracted from uranium minerals), and natural uranium oxides lead to the following conclusions relating to the effects of different oxidation rates of atoms of the two isotopes and on the effect of this process on the separation of uranium isotopes during their transfer from minerals to the liquid phase. Very fast oxidation of $^{234}U$ atoms in comparison with $^{238}U$ is not very characteristic of uranium-containing minerals, as for natural uranium oxides. In the separation of $^{234}U$ and $^{238}U$ during its transfer from the mineral to the liquid phase, this effect does not show any influence, as there is a surplus of $^{234}U$ independent of the presence of this process of extraction. For natural uranium oxides, hexavalent uranium always has a relative surplus of $^{234}U$ in comparison with composite uranium in minerals, that is, there is always the potential possibility of preferential transfer of $^{234}U$ into the solution during extraction because of the very fast oxidation of this atom. This possibility was realized only for samples of uraninite not subjected to hypergenic processes. In all other cases the ratio $^{234}U/^{238}U$ in extracts from minerals does not differ from the ratio in the composite uranium of the minerals. (tr-auth)

**45204** CANADA'S URANIUM INDUSTRY RECOVERS. Nucl. Eng., 13: 505-9(June 1968).

The outlook for the world market is discussed, and current Canadian mining operations are summarized. The programme of exploration and geological surveys is outlined. (UK)

## Oceanography

*Refer also to abstracts 45180 and 45978.*

**45205** (TID-24654) MEASUREMENT OF $^{226}Ra$ AND $^{228}Th$ IN SEA WATER. Moore, Willard S. (State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences). [1968]. 32p. Dep. CFSTI.

The first measurements of $^{226}Ra$ in the ocean are reported and analytical methods of determining $^{228}Ra$ and $^{228}Th$ are discussed. Measurable excesses of both $^{226}Ra$ and $^{228}Th$ exist relative to the $^{232}Th$ in the ocean. $^{226}Ra$ should prove a valuable tracer for studies of water movements. Its 6.7 year half-life makes it applicable to processes with a time scale of 3 to 25 years. (auth)

**45206** URANIUM DISEQUILIBRIUM IN ARABIAN SEA. Sarma, T. P.; Krishnamoorthy, T. M. (Bhabha Atomic Research Centre, Bombay). Curr. Sci. (India), 37: 422-4(Aug. 5, 1968).

The $^{234}U/^{238}U$ ratio in the Arabian Sea off the west coast of India was determined. A further objective of the study was to determine whether any difference exists between the values obtained and those of other researchers in the open and coastal waters. Four seawater samples of about 40 liters each were collected one mile offshore, and two shell samples from the beach at Tarapur. Chemical analyses were performed to determine the U content and the $^{234}U/^{238}U$ ratio. It was found that the input of uranium from land drainage into coastal waters is not significant enough to affect any isotopic differences between coastal and open ocean waters. (R.C.K.)

**45207** RADIOACTIVITY OF SEA WATER. Servant, Jean (CNRS, Paris). Cah. Oceanogr., 18: 277-318(Apr. 1966). (In French).

A review and bibliography relating to the radioactivity of the sea are presented. The physical aspects of the distribution of radionuclides and the chemical behavior of these radionuclides are examined. Carbon-14 and $^{90}Sr$ have been found to be important for the determination of the residence times of water masses in the oceans. The values of these residence times are very different for the Pacific and the Atlantic Oceans (650 and 800 yr) as well as for the Arctic and Antarctic Oceans (40 and 80 yr). Technically, the most promising method is that of the determination in situ of the concentration of $\gamma$ emitters. A radionuclide can be continually followed provided that its concentration is greater than $2 \times 10^{-12}$ Ci/l. The total reactivity of the elements is determined by their residence times in the oceans; the shortest is that of Al which is equal to $1.0 \times 10^2$ yr; the greatest is that of Na which is equal to $2.8 \times 10^8$ yr. The daughters of the natural radionuclides $^{238}U$, $^{235}U$, and $^{232}Th$ entering into the oceans by rivers have been studied, as well as the artificial radionuclides entering the oceans from the atmosphere. (BBB)

## Seismology

*Refer to abstract 45259.*

# ENGINEERING

## Nuclear Explosions

**45208** (ORNL-TM-2298) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, April 1–June 30, 1968. Arnold, W. D.; Blake, C. A. Jr.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). July 24, 1968. Contract W-7405-eng-26. 19p. Dep. CFSTI.

About 50% of the $^{90}Sr$, 35% of the $^{106}Ru$, and 12% of both $^{125}Sb$ and $^{137}Cs$ were dissolved at pH 1 when a new sample of test shot chimney rubble was leached with synthetic copper ore liquors. At pH 2 the amount of $^{90}Sr$ dissolved was about the same as at pH 1 but dissolution of $^{106}Ru$, $^{125}Sb$, and $^{137}Cs$ decreased to 30, 2, and 4%, respectively. At pH 3.6, the radioactivity of the leach solution was one percent of that at pH 1, and too low to permit analyses for the individual radionuclides. In batch distribution tests, $^{137}Cs$ was strongly adsorbed and $^{90}Sr$, $^{106}Ru$, and $^{125}Sb$ were weakly adsorbed from the leach solutions onto copper ore tailings. As in previous tests, $^{106}Ru$ was the principal radionuclide contaminating copper cemented from the solutions. The tritium contamination of Green River oil shale and of the oil retorted from the shale increased linearly with increasing temperature in the shale-tritiated water vapor system and with increasing tritium concentration in the water added to the reaction flask. The tritium concentration of the retorted oil increased 20 to 25% when the shale exposure time to tritiated water vapor at 85°C was increased from 8 to 25 days. More than 85% of the tritium was removed from contaminated shale (and also from the oil subsequently produced from that shale) by treating the shale in a sealed flask at 85°C with water vapor. The naphtha fraction from contaminated oil was examined in a gas chromatograph equipped with a radioactivity monitor. Tritium was present in each of the major component peak groups. (auth)

**45209** (UCRL-7870) CHARACTERISTICS OF NUCLEAR EXPLOSIVES. Frank, W. J. (California Univ., Livermore. Lawrence Radiation Lab.). May 11, 1964. Contract W-7405-eng-48. 6p. Dep. CFSTI.

Information concerning the size, cost, and radioactivity associated with nuclear explosives for peaceful uses is presented. (J.R.D.)

**45210** (UCRL-50425) GASBUGGY: POSTSHOT INVESTIGATIONS IN GB-ER. Korver, J. A.; Rawson, D. E. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 19, 1968. 28p. 28p. Dep. CFSTI.

Postshot reentry of the emplacement hole began on December 12, 1967, and terminated at a total depth of 3,916 ft on January 10, 1968. The hole below 3,000 ft was drilled with water and gel because of wet hole conditions. Two voids (from 3,856 to 3,862 ft and from 3,907 to 3,916 ft) and a number of casing breaks and offsets were encountered. Subsequent geophysical logging and short term flow tests suggests that the lower void could be considered part of the "chimney," but that it is only poorly connected with the major void volume. It is also felt that the chimney geometry is strongly influenced by horizontal fracturing, so that the chimney top is a poorly defined region of sags, or slump blocks. It must be recognized, however, that these conclusions are based on minimal data, and new information may alter them. (auth)

**45211** TEN YEARS OF PLOWSHARE. Jackson, Melvin W. (Holmes and Narver, Inc., Los Angeles). Contract AT(29-2)-20. Civil Eng. (N. Y.), 37: 34-8(Dec. 1967). (HN-20-1023).

The development of engineering uses for nuclear explosives in the past ten years is summarized. For commercial utilization, nuclear explosives must become competitive with rapidly changing technology in earthmoving and mining. The Plowshare project has been instrumental in developing peaceful uses of nuclear energy since its formation in 1957. (auth)

## Facilities and Equipment

*Refer also to abstracts 45246, 45260–45262, 45266, 45283, 46001, 46056, 46074, 46077–46081, 46090, 46091, 46093, 46203, and 47007.*

**45212** (ARH-SA-18) STUDY OF POLYETHYLENE BOTTLES AS CONTAINERS FOR PLUTONIUM NITRATE. Hoover, D. A.; Ingalls, W. P. (Atlantic Richfield Hanford Co., Richland, Wash.). June 1968. Contract AT(45-1)-2130. 25p. (CONF-681001-4). Dep. CFSTI.

From 2nd International Symposium on Packaging and Transportation of Radioactive Materials, Gatlinburg, Tenn.

High density polyethylene bottles have been used for the past two years as primary containers for plutonium nitrate solutions under both transport and storage conditions. During the first six months of use, some concern was evidenced because of leaks at the bottle seal, malfunction of the bottle vents, and stress cracks in the bottles. The results of an R & D program conducted to correct these problem areas are reported. (auth)

**45213** (BMwF-FBK-68-21) DETERMINATION OF THE CURRENT AND VOLTAGE CHARACTERISTICS OF THE 1.2-MJ CAPACITOR BANK AT THE KFA, JUELICH. Christou, I. (Technische Hochschule, Brunswick (West Germany). Institut fuer Hochspannungstechnik und Elektrische Anlagen). Dec. 20, 1967. 18p. (In German). Dep.

The determination of the current and voltage characteristics under various operating and disturbance conditions of the 1.2 MJ capacitor bank at the Institut für Plasmaphysik of the Kernforschungsanlage Jülich is described. At the outset, the equivalent circuit developed for the planned calculations is described. Measuring methods for the experimental determination of the elements of the equivalent circuit are then described. The calculated current and voltage characteristics on the loading-coil are included. The special case of a disturbance with the prefiring of a crowbar-gap is then dealt with. Numerical calculations have shown, among other things, that the overloading of individual circuit elements of the capacitor bank can be reduced in such a case with the help of a safety circuit. (auth)

**45214** (IPP-4/44) PROPERTIES OF IGNITRONS FOR 20 kv CAPACITOR DISCHARGE CIRCUITS. Gruber, J. E. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1967. 34p. Dep.

The properties of pulse Ignitrons are discussed. Measurements of delay, jitter, tube resistance and heating were carried out. In a reference list different makes of size A Ignitrons as well as some of the larger diameter Ignitrons are compared with respect to their pulse behavior. (auth)

**45215** (IPP-4/54) PRESSURIZED TWO-ELECTRODE SPARK GAP WITH SATURABLE INDUCTANCE. PART 1. EXPERIMENTS WITH VARIOUS FERRITE MATERIALS. Mark, E. v.; Wedler, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 29p. Dep.

Initial results in developing a compact pressurized two-electrode spark gap with saturable inductance for heavy duty are given. Experiments with various ferrite cores and ferrite materials are described. The maximum attainable voltage is defined as a function of the pulse steepness, the ferrite material, and the saturated inductance $L_{Fe0}$. The pulse breakdown voltage is investigated in pressurized air. The results show good agreement with calculations. Experiments with a 40 kJ standard unit are conducted to clarify problems such as arc migration and minimum electrode distance. (auth)

**45216** (IPP-4/55) PRESSURIZED TWO-ELECTRODE SPARK GAP WITH SATURABLE INDUCTANCE. PART 2. PULSE BREAKDOWN, ARC MIGRATION, AND SPARK GAP DATAS. Mark, E. v.; Wedler, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 54p. Dep.

Pulse breakdown voltage is investigated in pressurized air. The influence of irradiation, voltage and field strength gradient, pressure and gap distance are studied. The results show good agreement with calculations. Experiments with a 40 kJ standard unit are conducted to clarify problems such as arc migration and minimum electrode distance. Experiments to test the first prototype of an overvolted two electrode gap are underway. Jitter and delay time curves from the first measurements are discussed. (auth)

**45217** (IPP-4/59) CROWBAR SYSTEM IN ISAR I. van Mark, E.; Wedler, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 29p. Dep.

The 2.7 MJ capacitor bank ISAR I is described in reports IPP 4/12-1964 and IPP 4/26-1966. In the meantime a passive crowbar system has been added. The arrangement of the crowbar system is described. Special care went into the conception of a trigger system consisting of a "swinging trigatron", master spark gap, and 18 two-stage Marx generators. Further precautions are described to prevent prefiring of the crowbar spark gaps and the loading of a crowbar spark gap due to prefiring. (auth)

**45218** (NP-17446) SUMMARY EVALUATION OF CONCEPTUAL DESIGN FOR 50 MGD DESALINATION PLANT. Research and Development Progress Report No. 277. (Office of Saline Water, Washington, D. C.). Aug. 1967. 93p. Dep. GPO $0.60.

The ground rules specified for the design are enumerated. The designs from 15 contractors are classified and described. Cost factors including the validity of capital costs, operation and maintenance, labor and materials, pumping power and pumps, chemicals, and cost for process steam are discussed. (J.C.W.)

**45219** (NYO-3237-10) TURBOMACHINERY RESEARCH FOR NUCLEAR SYSTEMS. PART I. FEASIBILITY OF PROCESS-GAS LUBRICATION FOR HIGH-TEMPERATURE TURBINE-DRIVEN MACHINERY. PART II. AERODYNAMIC PERFORMANCE OF A GAS-BEARING TURBOCOMPRESSOR OPERATING IN A CLOSED BRAYTON CYCLE LOOP. Curwen, P. W.; Meacher, J. S. (Mechanical Technology Inc., Latham, N. Y.). July 1968. Contract AT(30-1)-3237. 226p. (MTI-68-TR-5). Dep. CFSTI.

Results of a program to determine the feasibility of applying gas-lubricated bearings to high-temperature machinery are presented. A brief summary of application areas is presented along with discussion of benefits likely to accrue from the applications. Feasibility demonstration is accomplished using a 24,000 rpm gas-bearing turbocompressor. The steady-state and transient aerodynamic performance of the turbocompressor is summarized. (J.R.D.)

**45220** (ORNL-tr-1976) DISASSEMBLY OF FUEL ELEMENTS. Final Report. Dluzniewski, Erich; Walther, Hans-Joachim (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). Translated for Oak Ridge National Lab., Tenn., from German report. 83p. Dep. CFSTI.

The design and operation of a system for disassembling fuel elements of the MZFR, FR-2, and VAK reactors are described. The overall system includes a disassembly machine, a fuel element chopper section, and means for the nitric acid leaching of $UO_2$ from the chopped fuel elements. Design drawings of the disassembly machine and all its auxiliary drives and controls are included. The system is concluded to be satisfactory for reprocessing plants of the designed size and output. (L.C.L.)

**45221** (SAN-651-65) ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM. Quarterly Progress Report No. 9, April 1-July 1, 1968. Internal Report No. AER-540. Niggemann, R. E. (Sundstrand Aviation-Rockford, Ill.). July 15, 1968. Contract AT(04-3)-651. 109p. Dep. CFSTI.

Activities in a program to develop a power conversion system capable of long duration operation in space are reported. Investigations are described concerning working fluids, bearings, and boilers. (auth)

**45222** (TID-4100(Suppl.46)) ENGINEERING MATERIALS LIST. Kelly, Robert C. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Aug. 1968. 49p. DTIE Free.

Twenty-nine packages of engineering materials are described. Drawings of the following equipment are included: fuel element monitor; air gun; pulse generator and discriminator; UNH pump components; pulse height-analyzer; solid state pulser; high temperature furnace; coincidence gate; vacuum gage; planetary swager; video repeater; Stanford Linear Accelerator research area; air monitor for $^{239}Pu$; motor control; eggshell strength tester; gloved alpha enclosure; survey meter; preamplifier; sample holder; computer-controlled mass spectrometer; optical tracking system; film transport; Hawaii Development Irradiator Facility; analog-digital converter; and 400 kW sphere beam dump. (R.C.K.)

**45223** DEVELOPMENT OF AN ADVANCED SODIUM TECHNOLOGY BY MEANS OF A 5 MWth TEST FACILITY. Harde, R. pp 493-526 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

Development work on a 5 MW(t) test facility to demonstrate the safety and reliability of sodium-cooled power reactor components is described. The task consists of finding and testing the most economical solution for the overall plant with consideration given to fabrication and materials problems. The facility should provide answers to the following problems: optimum peak sodium temperature; selection of construction materials; stationary and transient thermal stresses; the sodium-water reaction in the steam generator; and the control systems and partial load behavior. Schematic drawings are presented of the facility and control system. The construction schedule for the facility is given. (R.C.K.)

**45224** IMPROVEMENTS IN AND RELATING TO ULTRACENTRIFUGES. Christ, Martin. British Patent 1,119,420. July 10, 1968. Priority date Nov. 25, 1964, Germany.

A method is described for the operation of an ultracentrifuge vessel to become horizontal while the motor is being operated at low power. The electrical circuits are described for the gradient density ultracentrifuging operation. (J.C.W.)

**45225** IMPROVEMENTS IN DETERGENCY PRECISION WITH RADIOACTIVE SOIL. Shebs, W. T.; Gordon, B. E. (Shell Development Co., Emeryville, Calif.). J. Amer. Oil Chem. Soc., 45: 377-80(May 1968).

A radioisotope technique was developed for a more precise analytical method to measure the effectiveness of detergents. This method, based on the use of a doubly labeled radioactive ($^3H$ and $^{14}C$) artificial soil, employs liquid scintillation counting of the soiled fabric before and after laundering. The method for the analysis of wash water required little replication and achieved high precision (±2%). The method is based on the use of an inhomogeneous scintillator, which can emulsify, or at least suspend, large volumes of water in a liquid scintillator while maintaining good counting efficiency. Counting efficiencies were tested with 3 different scintillators. Studies of closure, i.e., amount of soil recovered in wash water plus fabric compared with soil introduced into the Tergotometer, demonstrated that the method is reasonably accurate and quite precise. (BBB)

**45226** SAMPLING FOR AIRBORNE RADIOIODINE BY COPPER SCREENS. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Physics, 15: 243-50(Sept. 1968).

The mechanism by which radioiodine vapor is absorbed by copper screen filters was investigated. An equation is given from which the effect of screen mesh size, wire diameter and face velocity on the efficiency of absorption can be calculated. (auth)

**45227** AUTOMATIC TRANSFER SYSTEM (Engineering Materials). (Los Alamos Scientific Lab., New Mex.). (CAPE-1757).

4 drawings.

A pneumatic system for transferring small plutonium samples from a storage chamber to an unshielded critical assembly for irradiation, then to a detection center to count delayed $\gamma$ rays from the fission products, and back to the storage chamber is described. Rapid automatic transfer makes it possible to analyze fission products with half-lives of a few seconds to a few minutes. (For details see TID-4100 Suppl. 47) (F.S.)

**45228** WELDING TORCH. Nelson, Ira V. (to United States Atomic Energy Commission). U. S. Patent 3,397,298. Aug. 13, 1968.

A welding torch is constructed in such a way as to eliminate from the hot end of the torch, certain seals normally required for use with lines that supply inert gas and liquid coolant to the hot end of the torch. According to the patent, a coolant tube has a curved middle section embracing a tubular core, with a tube for inert gas having a bent end inserted in a side opening in the tubular core, and a mass of metal applied by spraying to the outside of the tubular core which seals the inert gas tube to the core and thermally bonds the curved middle section of the coolant tube to the core. (AEC)

**45229** FRICTION WELDER. Cress, Hobart A.; Walls, James T. (to United States Atomic Energy Commission). U. S. Patent 3,396,893. Aug. 13, 1968.

An apparatus is described for friction-welding parts of metal, such as beryllium, by relatively rotating the parts against one another at high speed and low pressure and suddenly stopping the relative rotation by the use of pneumatic cylinder and piston to disengage a clutch and apply a brake. The piston acts with great force on the clutch and brake, because initial movement of the piston greatly increases the area of the piston subjected to high-pressure gas. (AEC)

**45230** ELECTRICAL SWITCH CONTACT RESISTANCE AT 4.2°K. Zar, J. L. (Avco Everett Research Lab., Everett, Mass.). Advan. Cryog. Eng., 13: 95-101(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A persistent current switch was designed for testing a large superconducting saddle magnet prototype for an MHD generator. The switch contacts were mechanically operated normal conductors, not superconductors. The contact surfaces studied were copper; fused and wiped tin and indium; and electroplated gold, silver and rhodium. Both freshly prepared surfaces and the same surfaces after a month's exposure to the laboratory atmosphere were compared at various contact pressures and gross

current densities. Aging produced an order of magnitude increase in the surface resistivity for all materials. At 4.2°K, the lowest surface resistivity measured was for freshly prepared silver surfaces and was $10^{-6}$ Ω $cm^2$ at all pressure above 50 psi. (auth)

**45231** DESIGN OF A GAS SPIN-UP SYSTEM FOR AN ELECTROSTATICALLY SUPPORTED CRYOGENIC GYROSCOPE. Bracken, T. D.; Everitt, C. W. F. (Stanford Univ., Calif.). Advan. Cryog. Eng., 13: 168-73(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A gas spin-up system capable of imparting spin speeds in excess of 150 $sec^{-1}$ to an electrostatically supported cryogenic gyroscope has been designed. The drag torque for spin-up is achieved by turbulent boundary layer flow of helium gas at 4.2°K and 2 cm Hg. In order to insure that voltage breakdown does not occur between the ball and supporting electrodes (.0015" spacing), the pressure in the electrode area must be maintained below .02 mm Hg. These low pressure electrode areas are isolated from the high pressure spin-up channels by means of an auxiliary pumping channel surrounding each spin-up channel. In preliminary experiments with a gas supported gyro, a maximum speed of 125 $sec^{-1}$ was attained. Data obtained by T. Edeli for the pressure dependence of electrical breakdown at 20 kc in helium gas at 4.2, 77 and 295°K are also presented. (auth)

**45232** SOME CONSIDERATIONS IN THE DESIGN OF A SUPERCONDUCTING ALTERNATOR. Oberhauser, C. J.; Kinner, H. R. (Dynatech Corp., Cambridge, Mass.). Advan. Cryog. Eng., 13: 161-7(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A laboratory prototype superconducting alternator is described. The purpose of this effort has been to investigate the feasibility of superconducting alternators for eventual use as low specific-weight sources of electrical power for space and airborne applications. This paper discusses the factors which influenced the design of the laboratory prototype machine and some of the solutions which were adopted. Preliminary performance data are also given. (auth)

**45233** A CABLED-WIRE MAGNET POWERED BY A FLUX PUMP. Lubell, M. S.; Wipf, S. L. (Westinghouse Research Lab., Pittsburgh, Pa.). Advan. Cryog. Eng., 13: 150-60(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A detailed description is given of a low-cost, light-weight integrated system consisting of a superconducting magnet wound with a cable of 49 strands of 10 mil dia Nb-25% Zr wire and a rotating magnet, Nb foil flux pump. With this system, a total current of 1,470 A (30 A/wire) was generated to produce a field of 39 kG in a 1 in. bore. Because of the end corrected design, the magnet had a homogeneity better than 1% over an axial distance at the center of 1.2 in. Pumping speeds of $7.5 \times 10^6$ G-$cm^2$/min were obtained with the rotor at 60 rpm. Power output of the pump was greater than 1 W and energy stored in the field was approximately 1200 J. Calculations are given of the actual efficiency and compared with the maximum power efficiency for various output powers for the maximum field produced. (auth)

**45234** A 14-TESLA 15-CENTIMETER-BORE SUPERCONDUCTIVE MAGNET. Coles, W. D. (Lewis Research Center, Cleveland, Ohio); Schrader, E. R.; Thompson, P. A. Advan. Cryog. Eng., 13: 142-9(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

The approaches used in the design and construction of the magnet were largely successful in meeting the design objectives and in providing protection for the magnet. Advantages offered by this large superconducting magnet are (1) ripple-free operation with little or no electrical noise from components or support equipment, (2) no acoustic noise or vibration, and (3) large volume at either room temperature or liquid helium temperature. The long charging time is a factor affecting the magnet's utility for some experiments. However, for other experiments the slow charging rate will be ideal. The property of shorting strips that adds to magnet stability and efficiency of energy dissipation also acts to limit the charging rate. The magnet is probably over-protected but the degree to which the protection could be safely reduced has not yet been assessed. (D.L.C.)

## Heat Transfer and Fluid Flow

**45235** (ANL-7420) TRANSIENT THERMAL STRESSES ASSOCIATED WITH SUDDEN INITIATION OF INTERNAL HEAT GENERATION IN A SEGMENT OF A CIRCULAR CYLINDER. Valentin, Richard A.; Schoeberle, Daniel F. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 28p. Dep. CFSTI.

An exact solution is given for the quasi-static thermal-stress field associated with the transient temperatures arising when an infinite, homogeneous, isotropic, right circular cylinder, cooled at its surface by a temperature-independent boundary conductance, suddenly begins, and thereafter maintains, uniform internal heat generation within a finite axial region. The problem is of interest in certain nuclear-reactor analyses related to the behavior of fuel elements during power transients. The solution form is well suited to numerical evaluation, and extensive numerical results are given. (auth)

**45236** (BNL-tr-220) STUDY OF LOCAL HEAT TRANSFER AND THERMAL FIELDS IN A SEVEN-ROD BUNDLE WITH AXIAL FLOW OF SODIUM. Pashek, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report UJV-1815. 43p. Dep. CFSTI.

This report was abstracted from the original language and appeared in NSA as 21: 45297. (R.C.K.)

**45237** (DSR-70332-55) DETERIORATION IN HEAT TRANSFER TO FLUIDS AT SUPERCRITICAL PRESSURE AND HIGH HEAT FLUXES. Shiralkar, Bharat S.; Griffith, Peter (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). June 30, 1968. 186p.

At slightly supercritical pressure and in the neighborhood of the pseudo-critical temperature (defined as the temperature corresponding to the peak in specific heat at the operating pressure), the heat transfer coefficient between fluid and tube wall is strongly dependent on the heat flux. For large heat fluxes, a marked deterioration takes place in the heat transfer coefficient in the region where the bulk fluid temperature is below and the wall temperature above the pseudo-critical temperature. An analysis has been developed, based on the integration of the transport equations, to predict the deterioration in heat transfer at high heat fluxes, and the results have been compared with the previously available experimental results for steam. Experiments have been performed with carbon dioxide for additional comparison. Limits of safe operation in terms of the allowable heat flux for a particular flow rate have been determined both theoretically and experimentally. Experiments with twisted tape inserted in the test section to generate swirl have shown that the heat transfer rates can be improved by this method. Qualitative visual observations have been made of the flow under varying conditions of heat flux and flow rate. (auth)

**45238** (GEAP-5497) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. Tenth Quarterly Progress Report, January 1-March 31, 1968. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 1968. Contract AT(04-3)-189. 12p. Dep. CFSTI.

In order to determine the nature of the liquid film, measurements will be made in two-phase steam-water flow at 600 to 1400 psia. The needle contact and conductance methods are available for measuring the film thickness. The porous sinter wall method of sucking off the liquid film and the scoop method are available for measuring the liquid film flow rate. Although the conductance method and porous sinter wall method appear to be the better methods of measuring film behavior, all available techniques will be further examined in a low pressure plexiglass channel. (auth)

**45239** (INR-901) ELECTRIC RESISTANCE ANALOGY FOR HEAT TRANSFER STUDIES. PART I. THE METHOD AND COMPUTER DESCRIPTION. Strupczewski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 48p. Dep.

A new resistance-network analog computer for the solution of heat-flow problems under transient conditions is described. In the computer, electrical networks represent the difference equations governing the problem to be solved. Temperature is represented by voltage, the spatial features of the problem by a network of parallel resistances, and the thermal constants by series resistances. A solution in steps $\Delta t$ of time is obtained by successive readjustments of potentiometers supplying the voltages to the network. The method is very flexible, the time interval $\Delta t$ and the thermal constants being adjustable during the progress of the work. The computer allows solution of problems involving heat transfer across a surface, or generation or absorption of heat in the interior of the system. The method can be also applied to latent-heat problems. One of the outstanding features of the computer is its stability, independent of the choice of time and thermal constants. Accuracies of better than 1 per cent can be obtained. (auth)

**45240** (K-Trans-41) INFLUENCE OF A NONUNIFORMITY OF INCIDENT FLOW ON THE CHARACTERISTICS OF COMPRESSOR STAGES WITH BLADES WITH A LOW ASPECT RATIO.

Polyakov, A. E. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Samoletostr. Tekh. Vozdush. Flota, 9: 22-4 (1967). 4p. Dep. CFSTI.

Results of an investigation of velocity field nonuniformity effects on the behavior of rotors and individual compressor stages are discussed. The experiments were conducted on the stand of a single-stage K-50-1 compressor with an outside diameter of 0.208 relative to the diameter of the rotor outlet of 0.77. The Reynolds number used was $\sim 3.15 \times 10^5$. It was found that an increase of the flow nonuniformity in the hub leads to an increase in the efficiency of the rotor. (J.R.D.)

**45241** (LA-DC-9781) THE INTERACTION OF CONTROL VALVES WITH OSCILLATIONS GENERATED IN A LARGE WATER TO HYDROGEN HEAT EXCHANGER. Henshall, J. B.; Nutter, M. J.; Edeskuty, F. J.; Thurston, R. S. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 8p. (CONF-680813-1). Dep. CFSTI.

From Cryogenic Engineering Conference, Cleveland, Ohio.

Experiments performed to investigate the limiting conditions for stable operation of 4.46-in. ID $H_2O-H_2$ heat exchangers are described. Emphasis is placed on the interaction of control valves at the heat exchanger inlet and outlet and their association with internal oscillations. It is concluded that it is possible to isolate the external system from the oscillations and that introduction of valves with a fast response into a system that generates oscillations can result in dangerously high oscillation amplitudes. (J.R.D.)

**45242** (ORNL-TM-2124) INVESTIGATION OF THE INTERACTION OF SOLID PARTICLES WITH FLUIDS IN TURBULENT PIPE FLOW. Brandon, Craig A. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 181p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The bulk of the previous studies of fluid-solid suspensions have been concerned with gases. The use of liquid-solid suspensions appears to offer unique advantages over other methods of turbulence promotion for desalination applications because suspended particles also may prevent scale formation and may aid in controlling the characteristics of hyperfiltration membranes. Therefore, the heat transfer to liquid-solid suspensions was studied. It was hypothesized that the enhancement of the heat transfer film coefficient in dilute suspensions may attain a maximum for particle sizes in the order of the Kolmogoroff microscale of the pipe flow turbulence. Information for water-solid suspensions was obtained to provide an additional test of this hypothesis. The heat transfer to water-solid suspensions of ten sizes of glass microspheres was measured for horizontal and upward vertical transport in 1-in. diameter steam heated pipes. The mean diameters of the uniformly-sized microspheres were 20, 32, 50, 60, 70, 100, 170, 370, 560, and 860 microns. The transport velocity range corresponded to Reynolds numbers from 20,000 to 90,000. The mean film coefficients were determined from overall heat transfer rates for solids concentrations to approximately 0.02 volume fraction. For selected tests, the local coefficients were determined from local measurements of wall temperature and condensate rates. Because the enhancements measured were generally <10%, the tests were conducted in sequence with a clear water reference test for each suspension test. A constant temperature hot-film anemometer was used to measure the longitudinal turbulence intensity within the central core of horizontal pipe flow of water and water-solid suspensions. Suspensions of 20, 32, 50, and 60 micron particles were studied. The particles had no measurable effect on the turbulence intensity. The effects of several sizes of particles on the pressure drop in the downstream region of a long ($L/D \approx 95$) horizontal test section were also measured. The friction factor increased with particle size from 20 to 170 microns and then remained constant for sizes to 560 microns. The water-solid suspension data were also consistent with the hypothesis of maximum enhancement of the film coefficient for particles sizes near the Kolmogoroff microscale. On a plot of enhancement versus the grouping, $\overline{dp}/\eta = \overline{dp}/D\ Re^{11/16}$, the same enhancement peak was traced out by varying the particle size at fixed transport velocity (i.e., at fixed microscale for the conditions of these tests) and by varying the velocity at fixed particle size. The microscale, $\eta$, was based on the maximum local rate of turbulent dissipation of the friction pressure loss energy. The correlation between the enhancement and $\overline{dp}/\eta$ was equally good for both the air-solid and the water-solid suspensions for both horizontal and vertical transport. However, both the optimum particle size and the magnitude of the peak enhancement were different between the two fluid-solid systems. The optimum particle size in the air-solid system was $\sim 1.5\ \eta$ and affected a peak enhancement of 80% for a solid concentration, $\phi = 0.001$. The optimum particle size in the water-solid system was $\sim 7\ \eta$ but affected an enhancement of only 3% at the same concentration. The enhancement increased roughly linearly with solid concentration being four times as great at $\phi = 0.01$ as at $\phi = 0.001$. A proposed fluid-solid interaction model, based on heuristic arguments about the structure of pipe flow turbulence and the inertia of the solid particle, yielded a relation for the optimum particle size, $dp/\eta = 10\ (\rho/\rho_s)^{\frac{1}{2}}$, that is consistent with the experimental results. A scaling factor for the peak enhancement is proposed based on the concept of a stopping distance of the solid particle in the fluid that may be temporarily quiescent after the interacting eddy is dissipated. (auth)

**45243** (TID-24636) THERMAL CONDUCTIVITY AND VISCOSITY OF NEON, HELIUM, ARGON, XENON, AND THEIR BINARY MIXTURES. Andrew, A. D.; Calvert, C. S. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Apr. 4, 1966. Contract AT(40-1)-2847. 28p. (GE-TM-66-7-9). Dep. CFSTI.

Relationships are presented for calculating the thermal conductivity and viscosity of the pure gases, neon, helium, argon, and xenon as functions of temperature. Also presented are recommended methods for determining the thermal conductivity and viscosity of monatomic gas mixtures. (auth)

**45244** NATURAL CONVECTION AND BOILING HEAT TRANSFER WITH $SF_6$ IN THE REGION OF THE CRITICAL POINT. Draper, R. Manchester, Eng., Univ. of Manchester, 1967. 244p.

Thesis.

A test facility was constructed in which the pressure and temperature of a fluid could be varied independently, and experiments conducted using an electrically heated horizontal tungsten wire as the heat transfer surface. The test fluid was sulphur hexafluoride. Over a range of conditions approaching the critical point, natural convection, nucleate boiling, and film boiling heat transfer were investigated. Natural convection at supercritical conditions was also studied. The test cells permitted visual observation of the heat transfer phenomena. A 16 mm sound cinefilm made in connection with the experiments is described. Experimental measurements are presented in graphical and tabular form and are compared with existing correlations not specifically applicable to near-critical conditions; a good measure of qualitative agreement was, however, evident. (auth)

## Isotope Technology

*Refer also to abstracts 45652 and 45766.*

**45245** (BNWL-716) ISOTOPE PRODUCTION AND AVAILABILITY FROM POWER REACTORS. Deonigi, D. E.; McKee, R. W.; Haffner, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 206p. Dep. CFSTI.

The projected availability of radioactive and stable isotopes from U. S. nuclear power reactors through the year 1990 is presented. The availability projections are for total spent fuel, U-235, U-236, total plutonium, Np-237, Pu-238, Am-241, Am-243, Cm-242, Cm-244, Pm-147, Ce-144, Cs-137, Sr-90, Kr-85, Ru-106, $^3H$, $^{99}Tc$, Rh-103, stable palladium, stable xenon, stable krypton, and stable ruthenium. Also included is a complete printout of the ISOPRO computer program for the eight different cases that were evaluated. (auth)

**45246** (COO-1422-36) CONSTRUCTION OF AN $^{125}I$ PHOTON SOURCE USING AN IMPROVED SOURCE HOLDER. Witt, R. M.; Sorenson, J. A.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Radiology). July 22, 1968. Contract AT(11-1)-1422. 6p. Dep. CFSTI.

The procedure used to construct an $^{125}I$ photon source for bone mineral scanning is described. The anion exchange technique is used. Details on the design and materials of the special $^{125}I$ resin bead source holder are given. (L.C.L.)

**45247** (EGG-1183-1395) ARMS AIRCRAFT RECOVERY OF LOST COBALT-60 SOURCE. Technical Report No. L-901. Weissman, V. F.; Hand, J. E. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). July 23, 1968. Contract AT(29-1)-1183. 9p. Dep. CFSTI.

The procedure for the recovery of a cobalt-60 source is described. The recovery aircraft radiation detection and measuring systems included NaI(Tl) detectors, radiation computer, strip chart recorder, and single channel and multi-channel pulse height analyzers. The recovery was simple and successful. (J.C.W.)

**45248** (MMM-3691-37) CHARACTERIZATION OF SNAP-21 AND SNAP-23A THERMOELECTRIC MATERIALS. (Minnesota Mining and Mfg. Co., St. Paul). Aug. 1, 1968. Contracts AT-(30-1)-3824; AT(30-1)-3691. 43p. (MMM-3824-0025). Dep. CFSTI.

Values of the Seebeck coefficient, thermal conductivity, and resistivity of 5 types of material used in converters and thermoelectric generators in SNAP-23A and SNAP-21 were determined as a function of temperature over the range of room temperature to 1300°C. General descriptions are given of the apparatus and procedures used. (P.G.C.)

**45249** (WANL-3800-16) SNAP-23A, PHASE 1. Quarterly Progress Report, March 1-May 31, 1968. Henderson, W. B. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 30, 1968. Contract AT(30-1)-3800. 147p. (WANL-PR-SS-016). Dep. CFSTI.

Progress is reported on the SNAP-23A, the Advanced Terrestrial Radioisotope Power System. Plans are reviewed for the project to investigate the Experimental Mockup System (EMS) failure and corrective measures are discussed and additional testing programs initiated. Systems design work on engineering, mechanical design, stress analysis, thermal analysis, thermoelectric analysis, and materials design support were discussed with the accompanying failures and investigations made during the disassembly. The failure is attributed to a catastrophic corrosion of the power and thermocouple feed through ports of the heat source jacket and short circuiting of the electrical heater within the heat source assembly. Design changes in the base assembly have been made and the projected results of the improvements summarized. The safety criteria were reviewed and additional objectives inserted. (J.C.W.)

**45250** RIPPLE GENERATORS. Yeats, F. W. (Atomic Energy Research Establishment, Harwell, Eng.). Newsletter Isotop. Generator Inform. Centre, No. 6, 19-33(May 1968).

The properties of the U.K. Isotope Powered Thermoelectric Generators (RIPPLE) are reviewed. The experience gained with the present generators built, showing the variations of performance with environmental temperature, lifetime and voltage output requirements, and the reliability obtained with the generators and their electrical powered simulators is outlined. Their efficiency and electrical output specifications are described, including the various methods of operating such generators with the required duty cycles. The target specification for the higher powered generators of between 8 and 50 W(e) output which are in the course of development is outlined. (auth)

**45251** MEASURING THE WEAR OF RUBBER TIRES BY MEASURING THE ABSORPTION OF THE BETA RADIATION OF $^{204}Tl$. Knoop, H.-U. (Technische Hochschule, Hanover). Kerntechnik, 10: 398-402(July 1968). (In German and English).

The wear of a rubber tire was measured using a beta radiation source containing $^{204}Tl$ inserted into several successive drill holes parallel to the rolling surface of the tire. The radiation penetrating the rubber was measured before and after each test trip. The thickness of rubber worn off was calculated from the increase of the measured radiation intensity. The radioactive source is not in the tire during the drive. A wear of 50 μm, corresponding to about 300 km of careful driving on a good road, can be measured with an error of only ±6%. (auth)

**45252** RADIO-ACTIVE POWER SOURCE. (to Secretary of the Army). British Patent 1,124,269. Aug. 21, 1968. Priority date Nov. 19, 1964, United States.

A strontium-90 power source design is given. The design includes the source material, an electron collector and emitter. (J.C.W.)

**45253** STATIONARY AND NONSTATIONARY CONCENTRATION DISTRIBUTIONS OF ISOTOPES IN SEPARATION COLUMNS. Meinrenken, J. (Univ., Goettingen, Ger.). Z. Naturforsch., 23a: 217-22(Feb. 1968). (In German).

The range of application of the theorem of independent separation, with whose help the spatial stationary concentration distribution of polynary isotope mixtures can be observed in the separation column without extraction, was expanded in connection with the selection of suitable relations between the separation factors of various isotope pairs to the calculation of the temporal nonstationary state in the separation column. In one-sided open separation columns without extraction, the distribution curve of the middle isotope of ternary mixtures in the stationary equilibrium shows a maximum, so that this maximum was carried through in similar magnitude during the temporal adjustment to the closed end. The middle isotope was therefore enriched under suitable conditions in a relatively short time. Under certain assumptions the middle isotope in nonstationary states can be even more enriched than in the equilibrium state. (tr-auth)

## Materials Testing

*Refer also to abstracts 45260-45263, 45764, and 45814.*

**45254** (BISRA-SM/B-16/66) ELECTRON PROBE MICRO-ANALYSER. Franklin, A. G. (British Iron and Steel Research Association, London (England). Steelmaking Div.). Oct. 7, 1967. 5p. Dep.

A review of the applications and potential of the BISRA microanalyser is given, under the following headings: introduction, instruments available, correction theory, applications in the steel industry, investigations carried out during 1965, present capabilities, future developments. (UK)

**45255** (GA-7852) SAFE-SHELL: A COMPUTER PROGRAM FOR THE STRESS ANALYSIS OF THIN-SHELL BODIES OF REVOLUTION. A USER'S MANUAL. Cornell, D. C. (Gulf General Atomic, Inc., San Diego, Calif.). June 30, 1967. Contract W-7405-eng-26; Subcontract 2848. 43p. Dep. CFSTI.

For [Oak Ridge National Lab., Tenn.].

A procedure for the numerical determination of the displacement, force, and stress fields in thin-shell bodies of revolution is presented. The computer program SAFE-SHELL, written in FORTRAN IV for the IBM 7044 computer, is described. (W.H.K.)

**45256** PRINCIPLES AND APPLICATIONS OF EMITTANCE-INDEPENDENT INFRARED NONDESTRUCTIVE TESTING. Green, Donald R. (Battelle Memorial Inst., Richland, Wash.). Appl. Opt., 7: 1779-89(Sept. 1968).

Three emittance-independent ir nondestructive testing techniques are described. Two of these use the dual scan ratio principle, and the other uses ir energy reflected from the test specimen surface to compensate for emittance differences. Complete details on the theory behind the three techniques are given. Instrumentation used to carry out tests and the results of two practical applications are described. (auth)

**45257** INFRARED TRANSIENT METHOD FOR DETERMINING THE THERMAL INERTIA, CONDUCTIVITY, AND DIFFUSIVITY OF SOLIDS. Schultz, Arnold W. (Avco Corp., Lowell, Mass.). Appl. Opt., 7: 1845-51(Sept. 1968).

A novel method has been developed for nondestructively determining the thermal inertia ($k\rho C_p$) of solids near room temperature. The method involves heating, with radiant energy, for a short time a small area on the surface of a solid whose dimensions are such that it appears semi-infinite during this period. Simultaneously, the characteristically shaped temperature rise of the central region of this area is observed using an ir radiometer as the sensor. A comparison of this history with that for a reference standard yields the local thermal inertia value. The localized thermal conductivity and diffusivity can then be determined if the density and specific heat are known. Present technique precision for good conductors is slightly less than that for destructive measuring techniques. (auth)

**45258** STUDIES ON ULTRASONIC INSPECTION OF ZIRCALOY TUBES. Aoki, Toshimasa; Tateishi, Yoshinori (Atomic Fuel Corp., Tokyo). Hihaki Kensa, 16: 511-17(Dec. 1967). (In Japanese).

An ultrasonic method for the sensitive inspection of thin-wall zircaloy sheath tubing is described. Experimental techniques, by which a shear-wave of zig-zag mode is propagated in the tube wall case, using a point focused transducer are described along with the test conditions for the inspection of the tubes. (auth)

## Protective Structures

**45259** (JAB-99-36) THREE-DIMENSIONAL DYNAMIC ANALYSIS OF HIGH-RISE BUILDINGS. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Aug. 1968. Contract AT(26-1)-99 56p. Dep. CFSTI.

A computer program developed to perform a complete three-dimensional dynamic analysis of high-rise buildings is described. A brief account of the theory of coupled translational and torsional vibrations of multistory buildings is also presented. Results obtained for a 24-story steel space-frame structure using this new program are presented and compared with results obtained from the two-dimensional dynamic analysis of the same building using an existing program. It is found that some of the gross responses like maximum centroidal displacements are in close agreement. However, the two-dimensional program yields considerably lower maximum member force responses of the beams and columns near the edges of the buildings, as well as maximum story torques. (auth)

## Radioactive Material Handling

*Refer also to abstracts 45196, 45227, 47013, and 47014.*

**45260** (EUR-3485(Vol.3)) EXAMINATION OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'S REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. STUDY OF THE BASIC ELEMENTS OF THE TYPE B PACKAGING TESTS AND OF A TYPICAL TEST STATION. Final Report. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1968. 132p. Dep.

The statistics and reports on serious accidents which occurred during the transport of radioactive materials or conventional goods were examined. These accidents were either impact-type or fire accidents involving various means of transport. It was concluded that the nine-meter drop test and the fire test specified in IAEA regulations are valid as representative tests for serious accident conditions. A standard test station for testing radioactive material packaging is described with a general outline of the test facility layout, and methods for effecting each test specified by the IAEA regulations are discussed. (auth)

**45261** (EUR-3485(Vol.4)) EXAMINATION OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'S REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. REPORT ON THE IMPLICATION OF THE TEST REQUIREMENTS FOR TYPE B PACKAGING AND A STUDY OF PRACTICAL SOLUTIONS. Final Report. (Societe pour les Transports de l'Industrie Nucleaire, Paris (France)). 1968. 323p. Dep.

Theoretical methods, or a combination of theoretical and experimental methods, to determine the effects of the conventional accident tests to which the regulations require "B" type containers to be subjected are reviewed. For the heat test an overall theory is described for establishing the chart of the temperatures attained at every instant and at all points of the container. There are certain difficulties, however, with the special case of containers fitted with external fins. In order to meet the after-test requirements it is generally advisable to limit such temperatures. This is done by using heat-resistant devices, of which several examples are given. The mechanical test, on the other hand, has very varying effects—overall deformations, local strains, stresses in the sealing elements, and an overall theory cannot be drawn up. By a combination of theoretical approaches and systematic tests, however, a quantitative evaluation of most of these effects is provided. To comply with the requirements it will often be necessary to limit certain of these effects; in most cases this can be done by using simple economical damper hoods, the theory of which is outlined. The study refers in general to lead-steel containers, but most of the theories and results are applicable to other types. (auth)

**45262** (EUR-3485(Vol.5)) EXAMINATION OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'S REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. REPORT ON THE IMPLICATION OF THE SAFETY CRITERIA FOR FISSILE MATERIAL PACKAGES AND A STUDY OF PRACTICAL SOLUTIONS. Final Report. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)). 1968. 101p. Dep.

A study was made of existing transport regulations on the packaging of fissile materials and of means of satisfying these regulations. The regulatory aspects of the transport of fissile material were examined, beginning with the historical development of IAEA recommendations and explaining the regulatory system in relation to the philosophy behind it. Some problems are outlined such as open frame birdcages, justification of some tests, definition of fissile class iii etc., furthermore, the state of the adaption of valid national and international regulations to the IAEA recommendations is discussed. The requirements of the regulations on containers for non-irradiated fissile materials are analyzed. These include mechanical integrity, fire resistance, and tightness. On the basis of detailed study, elements are proposed for integration into container construction for controlled deformation in accident, light weight fire protection and methods to ensure tightness under accident conditions. Some problems of testing methods are outlined. Finally some cases of nuclear transport on an industrial scale are described and container constructions are presented, which have been designed using the results of this study and which conform to the IAEA regulations. (auth)

**45263** (KY-D-2553) DEMONSTRATION FUEL ELEMENT SHIPPING CASK FROM LAMINATED URANIUM METAL: TESTING PROGRAM. Clifford, C. B. (Paducah Gaseous Diffusion Plant, Ky.). [1968]. Contract W-7405-eng-26. 36p. (CONF-681001-5). Dep. CFSTI.

From 2nd International Symposium on Packaging and Transportation of Radioactive Materials, Gatlinburg, Tenn.

The nondestructive and destructive testing programs performed at the Paducah Gaseous Diffusion Plant on the Demonstration Fuel Element Shipping Cask made from Laminated Uranium Metal are described. Details of the testing procedures and instrumentation are given. The cask damage resulting from the nondestructive and hypothetical accident testing programs was of a superficial nature, and it was limited to the deformation of fins and other sacrificial members near the points of impact. There was no leakage of liquid to the outside of the cask during any hypothetical accident test, and all of the dimensional changes were small except for those in the impact areas. No dimensional change experienced during the testing program would prevent the cask from being used for shipping spent fuel elements safely. The cask successfully met the applicable AEC Chapter O529, 10 CFR 71, and IAEA Safety Series 6 transportation and hypothetical accident series for shipping radioactive materials. The technical feasibility of using laminated uranium metal for structural and shielding materials in large radioactive material shipping casks was proven. (auth)

**45264** (KY-D-2554) ADVANTAGES AND ECONOMIC ASPECTS OF LAMINATED URANIUM SHIPPING CASKS. Loveland, C. W. (Paducah Gaseous Diffusion Plant, Ky.). [nd]. Contract W-7405-eng-26. 12p. (CONF-681001-6). Dep. CFSTI.

From 2nd International Symposium on Packaging and Transportation of Radioactive Materials, Gatlinburg, Tenn.

Experience obtained at the Paducah Gaseous Diffusion Plant in the design and fabrication of large isotope shipping casks, and the design, fabrication, and testing of the demonstration spent fuel element shipping cask serves as a basis for general assessment of the characteristics of uranium shielded shipping casks. Most of the Paducah experience was gained from building casks made of laminated uranium plate; however, much of the technology is directly applicable to casks made from uranium castings. This technology takes advantage of many of the properties of uranium and provides the means to control those factors which are potentially undesirable. A thorough testing program has indicated that a laminated uranium cask can successfully pass all of the tests prescribed in regulations. A fabrication direct cost factor of $1.36 per pound indicates that the total cost of a uranium shielded cask, when considered on a comprehensive basis, should be competitive with casks made using other materials. (auth)

**45265** (KY-F-96) DEMONSTRATION FUEL ELEMENT SHIPPING CASK FROM LAMINATED URANIUM METAL: DESIGN AND FABRICATION. Stitt, D. H.; Smith, V. A. (Paducah Gaseous Diffusion Plant, Ky.). [nd]. Contract W-7405-eng-26. 18p. (CONF-681001-7). Dep. CFSTI.

From 2nd International Symposium on Packaging and Transportation of Radioactive Materials, Gatlinburg, Tenn.

The design and fabrication of a demonstration fuel element shipping cask utilizing laminated depleted uranium metal as shielding material is described. The laminated uranium cask is designed to maintain a rigid shielding structure around the fuel cavity. The cask is so constructed to eliminate dimensional changes in the uranium shield and its inner and outer cladding. Crushable sacrificial members on the outside of the radiation shielding are provided to absorb the energy of impact loads under testing conditions established for hypothetical accidents. A detailed presentation is given of the fabrication, machining, cleaning, and heat treating operations followed on producing the cask. Machining characteristics of uranium are described and special control measures, fabrication, machining, and welding equipment requirements are detailed. Health Physics aspects of the specialized uranium handling and processing are described. (auth)

**45266** (NAA-SR-Memo-10549) HNPF SPENT FUEL SHIPPING CASK. Berger, S.; Halfen, F. J.; Hewson, R. A.; Nishizaka, J. M.; Ricci, T.; Stelle, A. T. (Atomics International, Canoga Park, Calif.). Oct. 9, 1964. 122p. Dep. CFSTI.

The design of a cask for shipping spent fuel from the HNPF to the Savannah River Plant is described. This design was made to conform to the criteria in AEC Regulation 10 CFR 72 (proposed) for shielding, criticality, decay heat removal, structural and exposure to fire, and to meet the Savannah River Plant acceptance criteria which are defined here. The spent fuel shipping cask can be used for shipping spent moderator cans by removal of the fuel element holder assembly and the addition of a $14\frac{3}{4}$" steel section to the cask body. Other irradiated core components such as process tubes, poison columns, and reflector filler elements, can also be shipped in this cask. (auth)

**45267** EXPERIENCE WITH LIQUID RADIOACTIVITY WASTE DISPOSAL. Yudin, F. P.; Pimenov, M. K.; Nazarov, A. I.; Zakharov, S. I.; Metal'nikov, S. V.; Sedov, V. M. At. Energ. (USSR), 25: 128-33(1968). (In Russian).

Several studies on liquid radioactive waste disposal into deep earth formations have been made on the industrial pilot plant at the Scientific Research Institute of Atomic Reactors. The plant was put into operation in April, 1966. The studies have been analyzed, the description of the geological and hydrological conditions of the area have been given, substantiation of the chosen absorbent level for the waste disposal and isotopic composition

of the waste have been given, and a diagram of the plant and the results of its operation are given. The method of underground disposal is compared with the method, based on evaporating of liquid wastes and refining them in special containers. The engineering and economic comparison of these two methods are given. It is shown that radioactive waste disposal underground as a method of rendering these wastes harmless, is a prospective one, which provides medical and radioactive safety at certain geological conditions. This method is economically feasible. (auth)

**45268** FIRE PROTECTION SHIELD FOR RADIOACTIVE SHIPPING CONTAINER. Bonilla, Charles F.; Brown, Steven H.; Miller, George P. (to National Lead Co.). U. S. Patent 3,391,280. July 2, 1968. Filed Nov. 6, 1964.

A shipping container for radioactive material is described which is surrounded by a spaced fire protection shield. The fire protection shield allows air to freely circulate within the shield at normal temperatures to remove decay heat. Air flow control means is provided to stop the air circulation at a predetermined temperature to prevent hot air from entering the shield and heating the container. (Offic. Gaz.)

**45269** IMPROPER LABELLING OF RADIOACTIVE SHIPMENTS. Delahunty, N. (Atomic Energy of Canada Ltd., Ottawa). Health Phys., 15: 283(Sept. 1968).

Occasionally an express or road transport shipment has been received which bears an address label containing such wording as "This Package May Be Opened For (Postal) Inspection." In other words, the shipper has used a label normally affixed to non-radioactive shipments, or parcel post packages. It is felt that the use of this label on a radioactive shipment is dangerous, inasmuch as it conceivably might give the impression that there would be no hazard in opening the container. It is suggested that health physicists check with their shipping departments to ensure that such labels are not being used for radioactive shipments. (auth)

**45270** RECOVERY OPERATIONS FOLLOWING AN AIRCRAFT ACCIDENT INVOLVING RADIOACTIVE CARGO. Carach, J. (Reginal Inst. Hygiene, Bratislava); Csupka, S.; Petrasova, M.; Trnovec, T.; Minarik, F. Health Phys., 15: 280-2(Sept. 1968).

Emergency actions and findings related to recovery operations following an aircraft accident which involved the dispersion of 2.25 Ci of $^{131}I$ are described. The accident occurred on 24 November 1966 in mountainous terrain 12 km northeast of Bratislava during a snow storm which blanketed the scene to a depth of 40 cm. (auth) (UK)

## Vacuum Engineering

**45271** MOLECULAR BEAM STUDIES OF CRYOPUMPING. Brown, R. F.; Heald, J. H. Jr. (ARO, Inc., Tullahoma, Tenn.). Advan. Cryog. Eng., 13: 243-51(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

An aerodynamic molecular beam chamber and a modulated molecular beam detector system have been constructed at the Arnold Engineering Development Center. Applications of molecular beam techniques in a study of the basic condensation phenomena at cryogenic temperatures are discussed. Data relating to the temperature at which condensation begins and the effect of precoating on the effective capture coefficient of a typical copper cryosurface are presented. The thickness of deposit necessary to eliminate the "bare surface effect" was determined for a beam of $CO_2$, and the data generally agree with condensation theory. (auth)

# INSTRUMENTATION

## Radiation Detection Instruments

### *General Detectors and Monitors*

*Refer also to abstracts 45508, 45556–45558, 45562, 45563, 46658, 46664, 46666, 46667, 46671–46692, 46729, 46805, 46807, and 47027.*

**45272** (AAEC/M–84) ALPHA-BETA-GAMMA SURFACE CONTAMINATION MONITOR A.A.E.C. TYPE 165. Bransgrove, A. N.; Cecers, K. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 17p. Dep.

The A.A.E.C. Type 165 monitor is a portable instrument, fitted with re-chargeable batteries and designed for a variety of uses by health physicists or persons working in areas contaminated by radioactivity. Fitted with one scintillation alpha probe and one G–M beta–gamma probe, the instrument registers 0–10,000 counts/sec in four linear ranges. An alarm may be pre-set at low radiation levels. The instrument also has connections for external scalers and recorders. (auth)

**45273** (AERE-R-5749) REDUCTION OF X-RAY PROPORTIONAL COUNTER BACKGROUND BY PULSE SHAPE DISCRIMINATION. Snelling, G. F. (Atomic Energy Research Establishment, Harwell (England)). May 1968. 23p. Dep. CFSTI. UK 4s. 6d.

The rise times of pulses produced by x-rays within an x-ray proportional counter are well defined and shorter than those of most of the background pulses. It is practicable to remove most of the background spectrum by means of pulse shape discrimination. The method adopted, using Harwell 2000 Series Units, together with some of the results obtained with a range of differing x-ray proportional counters, is described. (auth)

**45274** (BARC–330) DESIGN OF PROTON RECOIL COUNTERS WITH MULTIPLE RADIATORS. Muthukrishnan, G.; Murthy, K. B. S.; Sunta, C. M. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 24p. Dep.

Two types of counters for fast neutron dosimetry and for neutron flux measurement have been developed using a proportional counter with multiple proton radiators. Calculations have been done for the counter response using CDC 3600-160A computer for polythene radiators of thickness varying from 0.01 mm to 3 mm and for incident neutron energies from 0.3 to 16 MeV. These computations along with that of the burshane gas response are used to select the pressure of the gas, thickness of the solid radiators and the proportions of their areas such that the overall response of the counter is as close to the desired response as possible. The energy response of the counters is experimentally studied using monoenergetic neutrons. The experimental and the calculated responses are in good agreement. (auth)

**45275** (CEA-Bib-97) PN JUNCTION FOR THE DETECTION OF $\alpha$ AND $\beta$ PARTICLES AND OF ELECTROMAGNETIC RADIATIONS. Ristori, Christian (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1968. 32p. (In French). Dep.

Thesis.

The theoretical study of p–n junction, the study of the various characteristics of diffused p–n junctions, surface barrier junctions, and p–i–n junctions compensated with lithium, and finally the applications of these detectors in the field of the detection of heavy particles, of beta particles and of electromagnetic radiation (gamma and infrared) are presented. (auth)

**45276** (CERN–68–33) BEAM-PROFILE ANALYSER USING PROPORTIONAL MULTIWIRE CHAMBER. Amato, G.; Petrucci, G. (European Organization for Nuclear Research, Geneva (Switzerland)). Aug. 6, 1968. 9p. Dep.

The design and results of preliminary tests of proportional multiwire chambers for analysis of the beam profile of high-energy secondary beams from a proton synchrotron are presented. The system consists of two multiwire chambers, wire pulse amplifiers, a channel analyzer, a channel scanning system, and an oscilloscope. (W.H.K.)

**45277** (CNEA–204) ESCALIMETRO PORTATIL. (Portable Scalar). Garcia, O.; Kopp, M. C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1967. 20p. (In Spanish). Dep.

A prototype of a portable scaler, especially adapted for field equipment for the measurement of soil density and humidity, was constructed. The instrument, which is totally transistorized, contains in a cabinet a four-decade scaler, high voltage source for the polarization of G-M detectors, and a digital timer which indicates the time with a precision of the tenth of a second. The result of each count is presented in a four-cipher mechanical counter, which indicates the time needed to accumulate a prefixed quantity of counts coming from the detector. The correct functioning of the scaler was proven by means of the Pearson $\chi^2$ test. A calibration curve was constructed for the density meter. (tr-auth)

**45278** (JINR–P3–3904) CHARACTERISTIC INVESTIGATION OF THE GAS SCINTILLATOR IN THE ELECTRIC FIELD FOR CHARGED PARTICLE DETECTION AND SPECTROSKOPIE. Kvitek, I.; Nechaeva, E. I.; Popov, Yu. P.; Ribanski, I.; Rumi, R. F.; Stempin'ski, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 13p. (In Russian). (CONF-680624–1). Dep.

From 5th All-Union Conference on the Synthesis, Production, and Use of Scintillators, Kharkov, USSR.

Here there are given some characteristics of the gas scintillator placed in the electric field. The possibility of constructing the detector and the spectrometer for charged particles on the gas scintillators in the field basis is also considered. (auth)

**45279** (LA–3966) WHOLE-BODY NMR SPECTROMETER. Jackson, Jasper A.; Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). June 1968. Contract W-7405-eng-36. 12p. Dep. CFSTI.

A low-frequency NMR spectrometer was built that will accommodate sample volumes of 0.2 to 1.25 liters. A shielded solenoid provides a uniform field of about 10 G. Signals are detected by a symmetrical rf bridge whose coils are bank wound of litz wire with Q ~ 300 to 400 at 40 kHz. In the smaller coil homogeneity is sufficient to distinguish signals of protons in protein from those in fat and water. Proteins show a broad resonance underlying the fat and water resonance that is not clearly resolved. The broad resonance is identified with protein by spectra of pure $H_2O$ (sharp peak only) and gelatin made with $D_2O$ (broad peak only). Protein hydration water is believed to be included in the main water peak. Lard is used to identify the signal from fat. Some unidentified lines are occasionally seen. Spectra were obtained from gelatin, whole eggs, egg whites, egg yolks, and dead mice. In addition, what is believed to be the first NMR signal ever obtained from a whole living animal was taken on an anesthetized rat. Potential application to analysis of living animals into their whole-body composition is discussed as is detection of signals from other nuclei. (auth)

**45280** (NYO–3246–TA–2) APPLICATIONS OF AVALANCHE TYPE SEMICONDUCTOR RADIATION DETECTORS. Annual Report, July 1967–July 1968. Johnston, Phillip A.; Huth, Gerald C. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). June 1968. Contract AT(30-1)-3246. 23p. Dep. CFSTI.

The development of avalanche-type semiconductor detectors for x-ray fluorescence analysis is described. Avalanche detector technology with balanced filter techniques and radioisotope sources are discussed. Avalanche detector response to x radiation is described. Development of an avalanche detector x-ray fluorescence instrument for planetary geochemical exploration, and results obtained with a prototype instrument using a 4 mC polonium-210 alpha emitter and a 1 mC iron-55 x-ray source are discussed. (W.H.K.)

**45281** (NYO–3246–TA–3) RESEARCH ON AVALANCHE TYPE SEMICONDUCTOR RADIATION DETECTORS. Semiannual Report, January–June 1968. Huth, Gerald C.; Locker, Robert J. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(30-1)-3246. 68p. Dep. CFSTI.

After a brief introduction on the characteristics of avalanche-type semiconductor detectors, results of a study on avalanche gain uniformity are presented. The results of an effort to measure and develop the response of silicon avalanche detector to low-energy electrons at 5 to 40 keV are also presented. Temperature compensation for avalanche detectors was investigated. Several applications for avalanche detectors were included. These were for plutonium detection in wounds, krypton-85, prototype heart catheter, and carbon-14 detection measurements. An appendix is included on the conceptual design for a flying spot scanning apparatus for measurement and study of gain uniformity in avalanche radiation detectors. (B.C.D.)

**45282** (ORNL-tr–1946) PULSE-SHAPE DISCRIMINATION FOR BORON-LOADED LIQUID SCINTILLATION DETECTORS. Suetterlin, L. Translated for Oak Ridge National Lab., Tenn., from Atomkernenergie, 12: 287–8(1967). 5p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 21: 27231. (W.H.K.)

**45283** (PHS-999-RH-31) AN ACCLIMATION ROOM FOR THE DETECTION OF LOW $^{226}$Ra BODY BURDENS. Campbell, Samuel D.; Body, Denis E. (National Radiological Health, Rockville, Md.). Feb. 1968. 19p. GPO.

A mobile breath radon detection apparatus has been used for measuring low radium-226 body burdens. The unique feature of the apparatus is an acclimation room designed to accommodate subjects for periods up to 1 week in a low-radon environment. Radon concentrations in the acclimation room have been reduced to an operating level of 0.0005 pCi per liter, a reduction of approximately 600:1, by an air processing unit employing activated coconut charcoal. This apparatus permits determination of very low radium-226 body burdens in comfortable surroundings for two subjects simultaneously, during the extended periods required for elimination of previously inhaled radon from the body. The construction and operation of the acclimation room and breath sample collection are described. Radium-226 body burdens for the subjects and a radon elimination curve for one subject are included. (auth)

**45284** (UCRL-17663(Rev.1)) RANGE ENERGY TABLE FOR HEAVY PARTICLES IN SILICON. Bichsel, Hans; Tschalaer, Christoph (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 32p. Dep. CFSTI.

Stopping-power S and range R tables for protons, deuterons, tritons, $^{3}$He, $^{4}$He and $^{7}$Li ions of energies between 1- and 200-MeV penetrating silicon absorbers are presented. Auxiliary data include tables for the coefficients C and $\alpha$ needed for the approximate expression $S = C \cdot E^{\alpha}$ and figures giving the energy dependence for the coefficients of $R = C_R \cdot E^{\beta}$. A short review is given of principles to be considered in detector applications. (auth)

**45285** SIMPLIFIED PROCEDURE FOR CALCULATING THE COUNTING RATE OF DETECTORS AND DETERMINATION OF OPTIMAL DIMENSIONS OF MEASURING VOLUMES IN THE RADIOMETRY OF BETA-ACTIVE GASES. Korotin, B. A.; Mysev, I. P.; Ryabova, E. A. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr., No. 1, 44-53(1964). (In Russian).

One of the most reliable and simplest methods of measuring the concentration of $\beta$-active gases, the method of direct registration of the activity of the gas (contained in a limited volume) with the aid of gas-discharge or scintillation counters, is considered. The analytic expressions that relate the counting rate of the detector with the concentration of the $\beta$-active gas are complicated and cumbersome when rigorous account is taken of the geometry of the measurement and absorption of the $\beta$ radiation by the medium, so that their practical use is very limited. Since a calculation accuracy of ~15-20% is perfectly adequate for many problems, it is possible to simplify the formulas and make them more universal for the determination of the sensitivity for different geometries of the measuring gas volumes. A method of obtaining simpler qualitative relations is described. The counting rate $N_0$ of a point-like detector is calculated without account of $\beta$-particle absorption. From an analysis of the data obtained for non-point and point-like detectors, the correction for the deviation from a point is calculated and is found to be close to unity. Similarly, the correction for absorption is determined from a comparison of the expression for $N_0$ with the expression in which account is taken of the $\beta$-particle absorption for a point-like detector. (ATD)

**45286** USE OF SEQUENTIAL STATISTICAL ANALYSIS IN MEASUREMENT OF NUCLEAR RADIATION. Golosovskii, A. M.; Ioannesyants, L. M.; Karpinskii, I. P.; Kreindlin, I. L. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr., No. 1, 213-32(1964). (In Russian).

The application of the method of sequential statistical analysis for sorting radioactive samples by their activity is considered. For the case of a Poisson distribution, this problem can be formulated in the following manner. If m pulses were registered in a time $t = T$ and if $m \leq N$ (where N is the limiting number of pulses), then hypothesis $H_1$ is assumed, and if $m = N$ after $t < T$, then hypothesis $H_2$ is assumed. In the method of sequential statistical analysis, the choice between the hypotheses reduces to a verification of the inequality $\ln B < Z < \ln A$ (1), where Z is the logarithm of the likelihood ratio, and the numbers A and B are determined from the relations $A = (1 - a_2)/a_1$ and $B = a_2/(1 - a_1)$, where $a_1$ and $a_2$ are probabilities determined by the formulas $a_2 = \int_0^{\lambda_{threshold}} f(x\lambda_2)dx$ and $a_1 = \int_{\lambda_{threshold}}^{\infty} f(x\lambda_1)dx$. $f(x\lambda)$ is the known probability density function, and $\lambda$ is the distribution parameter. The verification continues until inequality (1) is satisfied. If inequality (1) is violated on the left, the verification terminates by assuming the hypothesis $H_1$. If it is violated on the right, then $H_2$ is assumed. Formulas are presented for the calculation of the operative characteristic $L(\lambda)$ and the average measurement of time $A(\lambda)$, and the peculiarities and consequences of these formulas are discussed. Some graphical interpretations and examples of applications of sequential analysis are considered. (ATD)

**45287** APPARATUS FOR MEASURING BLOOD FLOW BY RADIOACTIVE TRACER. (to Societe Nationale Des Petroles D'Aquitaine). British Patent 1,096,448. Dec. 29, 1967. Priority date Feb. 22, 1965, France.

The design of a scintillation detector and the associated circuitry including AND-gate, binary counter, clock generator, memory unit, digital-to-analog converter, and display unit for measuring the blood flow in an organ into which a radioactive tracer has been injected is described. (W.H.K.)

**45288** CONSIDERATION ON THE DIAGNOSIS OF MALIGNANT TUMOR WITH P-I-N TYPE SEMICONDUCTOR DETECTOR. Higashi, Tomomitu (Kanagawa Dental Coll., Yokosuka City, Japan); Ikemoto, Sinichi; Suzuki, Sinji; Mogi, Mikio; Nagahara, Teruaki; Hattori, Manabu; Takata, Mamoru. Radioisotopes (Tokyo), 17: 311-16(July 1968). (In Japanese).

For its compactness, unfragility and safety, the semiconductor detector has been used currently as a radiation detector. However, the utilization of this detector in the medical field is still underdeveloped. Its medical utilization has been previously discussed. Its utilization for detection of cancers in the digestive organs is reported. This detector was inserted in the cavity 24 hours after intravenous injection of 250 $\mu$Ci $^{32}$P and the amount of $^{32}$P uptake in the cancerous tissue was measured. A considerable increase of $^{32}$P uptake was marked in the cancerous tissue, which was found to be useful for estimation of the region of the cancer. (auth)

**45289** FISSION ELECTRIC CELL. PRELIMINARY EXPERIMENT. Mori, Michiaki; Matsui, Tsuneo (Hitachi Shipbuilding and Engineering Co., Ltd., Japan). Hitachi Zosen Giho, 29: 131-8(May 1968). (In Japanese).

A method of neutron flux measurement is presented based on fission products, which excite and ionize gas between two electrodes, one coated with a uranium layer and another uncoated. Since this cell is different from the ordinary fission chamber, external voltage is not needed. The results of the experiment show that output electric currents, which flow in external circuit, are nearly proportional to reactor power (neutron flux), and transient response between them is highly sensitive. (NSA of Japan)

**45290** ENERGY LOSS OF CHARGED PARTICLES IN SCINTILLATORS. Polyakov, O. A. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr., No. 2, 28-37(1965). (In Russian).

Formulas and curves are presented, which make it possible to determine the energy lost by protons and electrons passing through layers of organic and inorganic scintillators of different thickness. The part of energy loss curves of protons with initial energy 10-10,000 MeV is presented for NaI crystals 0-15 g/cm$^2$ thick. The same relations are plotted for stilbene crystals 0-4 g/cm$^2$ thick at proton energies ranging from 10 to 2000 MeV. The Bethe-Bloch formula was used to calculate the mass decelerating ability of NaI in the case of protons and the data of Starodubtsev and Romanov (Prokhozhdeniye zaryazhennykh cherez veshchestvo [Passage of Charged Particles through Matter], Tashkent, Iz-vo AN UzSSR, (1962)) and the data of Rich and Mady were used to obtain the mass decelerating ability of the stilbene. The Landau formula was used in the calculations of the electron energy loss in the stilbene. The energy loss of the electrons in inorganic scintillators was calculated with the aid of the approximate formulas for the dependence of the extrapolated range of electrons on their energy. (ATD)

**45291** SEPARATION OF THE FAST AND SLOW COMPONENTS IN SCINTILLATION COUNTERS USING COMPOSITE PHOSPHORS. Gorn, L. S.; Isaeva, R. N.; Pomogaev, V. V. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr., No. 2, 11-23(1965). (In Russian).

Optimal conditions for the separation of luminescent components in a scintillation counter using a composite scintillator are studied. A formula is derived which makes it possible to calculate the separation factor of the fast and slow component for a pulse-shape discrimination circuit. (ATD)

**45292** INCREASING OF EFFICIENCY OF BETA COUNTING SCINTILLATOR BY USING 1,4-Di(2-(5-TOLYLOXAZOLYL))-BENZENE (T.O.P.O.T.). Tubertini, Ottavio (Univ., Bologna. CNR, Bologna). Ric. Sci., 38: 136-8(Feb. 1968).

The use in radiochemical analysis of 2,2'-p-Phenylenebis[5-tolyoxazole] as a modified secondary scintillator for increasing the counting efficiency in liquid phase is investigated. (W.H.K.)

**45293** ZERO-WALK CHARGE STORAGE DIODE DISCRIMINATOR FOR FAST COINCIDENCE SYSTEMS. Griffin, J. E.; Souder, W. W. (Iowa State Univ., Ames). Nucl. Instrum. Methods, 64: 85-92(Sept. 1, 1968).

The use of charge storage diodes in conjunction with discrimination of fast scintillation detector pulses is described. It is demonstrated that the snap-off time of such devices can be made independent of the incident pulse amplitude. Several such circuits are shown. A technique for evaluation of such circuits in prompt coincidence systems is described. (auth)

**45294** DIGITAL STABILIZATION IN DELAYED COINCIDENCE SYSTEMS BY LIGHT PULSING. Griffin, J. E.; Souder, W. W. (Ames Lab., Iowa). Nucl. Instrum. Methods, 64: 80-4(Sept. 1, 1968). (IS-1809).

A fast (2 nsec) light pulsing system is described employing the light emission characteristics of silicon p-n junctions. Application is described to digital stabilization of fast delayed coincidence systems of the time-amplitude conversion type. (auth)

**45295** STUDY OF ACTUAL SCATTERING FROM MEASUREMENTS BY A TYPE-A.I.S.C. NEUTRON DETECTOR BY COMPARISON AMONG THREE SECTIONS. Berry, J.; Milleret, G.; Freon, A. (Laboratoire de Physique Cosmique, Verrieres le Buisson, France). Nucl. Instrum. Methods, 64: 45-51(Sept. 1, 1968). (In French).

The actual accuracy of the NM 64 neutron monitor, taking into account the statistical errors, the neutron multiplicity inside the detector and the instrumental errors, is studied from the Pic du Midi data. The detector is divided into three similar independent sections of three counters. The hourly counting rate is near to $2.5 \times 10^6$, the scaling factor being equal to 1000; this number is taken as variation unit. The level of significance of the variations of the total counting rate is estimated by the correlation between the algebraic increases observed in each section, for all cases in which the total increase is constant in absolute value. The result of the application of this method to the September–October 1965 Pic du Midi hourly data is given. It is shown that variations exceeding 4 or 5 units have surely a physical meaning. Then the theoretical value of the correlation is calculated; we found that the actual standard deviation of the variations is equal to the increase of the total counting rate which gives no correlation between the sections. It has been found 1.6 times greater than the statistical error. A method giving the standard deviation of the values of each section is given. The numerical results are quite similar to those of the preceding analysis. It is found that the amplitude distribution of the error is close to a Gauss distribution. (auth)

**45296** THE RELATIVE DETECTION EFFICIENCY CALIBRATION OF A Ge(Li) DETECTOR AT LOW ENERGIES. Donnelly, D. P.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 64: 26-8(Sept. 1, 1968).

The relative detection efficiency of gamma-ray full energy peaks in the energy region 20 to 100 keV was determined using a modified pair-point method. An overall accuracy of 15% was obtained in this energy region. (auth)

**45297** STUDY OF THE INFLUENCE OF THE APERTURE OF COUNTERS ON THE MEASUREMENT OF DIFFERENTIAL CROSS SECTIONS. Massot, J. N.; Sau, J.; Chery, R.; Lafoucriere, J. (Univ., Lyon). Nucl. Instrum. Methods, 64: 1-6(Sept. 1, 1968). (In French).

Detection of particles by a counter with a large aperture has been studied. The general expression of the partially integrated cross section is deduced and it is shown how one can obtain from it very simply the differential cross section. It is therefore possible to use systematically a counter with a large aperture; the resulting advantages are to be found either in important statistical improvement or in a shorter working time. Finally this study allows us to show how far a counter with a narrow aperture can be considered as a pin-point. (auth)

**45298** THEORETICAL COMPARISON BETWEEN PULSE-AREA AND PULSE-HEIGHT ERRORS PRODUCED BY COLLECTION-TIME VARIATIONS. Connelly, J. A.; Pierce, J. F. (Univ. of Tennessee, Knoxville). Nucl. Instrum. Methods, 64: 7-12 (Sept. 1, 1968).

Although pulse-height analysis is widely used in nuclear spectroscopy, the energy resolution using this technique is degraded by several factors, one of the more important being the charge collection-time variation. Resolution errors resulting from this variation can be reduced significantly by the more recently introduced area-to-amplitude conversion technique. To investigate the advantages of this technique, a mathematical treatment of the area-to-amplitude (AAC) technique using delay-line clipping was developed. The resolution error as a function of integrating time was then derived. From the resulting equations, an error chart was developed to facilitate the evaluation of practical systems. A general class of input driving functions was also analyzed and discussed. A comparison between the area-to-amplitude conversion technique and the peak-amplitude detection technique indicated that, under most conditions, the AAC technique produces a significantly smaller resolution error. (auth)

**45299** INSTRUMENTATION IN NUCLEAR MEDICINE. Volume 1. Hine, Gerald J. (ed.). New York, Academic Press, 1967. 673p. $27.50; 220s.

The fundamental and recent developments of all important instruments used in nuclear medicine are described. The theoretical as well as experimental aspects are presented together with specific information on applications. Topics discussed were radioisotopes and labeled compounds, the radioisotope laboratory in the general hospital, basic considerations in nuclear instrumentation, radiation detectors, systems for data accumulation and presentation, radiation safety instruments, preparation of samples for liquid scintillation counting, liquid scintillation counting equipment, radiochromatographic counting techniques, gamma-ray counting, nuclear activation analysis, thyroid radioiodine uptake in medicine, in vivo tracer studies by external gamma-ray counting, radioisotope scanning, radioisotope scanners, whole-body counting and large organic scintillation detectors. (B.G.D.)

**45300** TECHNIQUES OF AUTORADIOGRAPHY. Rogers, Andrew W. Amsterdam, London, and New York, Elsevier Publishing Company, 1967. 344p. $20.00.

Starting from the principle on which all autoradiography rests, the uses of nuclear emulsions to record the tracks of charged particles, resolution, efficiency, and background are defined, and the factors influencing them in various experimental situations are discussed. A detailed discussion is also presented on the various groups of autoradiographic techniques, ranging from whole-body autoradiography to autoradiography in the electron microscope. (B.G.D.)

**45301** ELECTRON DETECTION BY SEMICONDUCTOR COUNTERS IN THE HIGH INTENSITY $\gamma$-RAY BACKGROUND. Makovskii, L. L.; Strokan, N. B. At. Energ. (USSR), 25: 125-8(1968). (In Russian).

The influence of considerable decreasing of counter width on the decreasing of background from gamma-rays is analyzed. The shape of the Compton electrons amplitude spectrum is established provided that the range of electrons is linear. It is shown that effective decreasing of the number of impulses induced by gamma-rays takes place under the decreasing of counter width to the value when energy emitted by electrons counted slightly exceeded the energy of Compton electron spectrum. (auth)

**45302** $^{133}$Xe-REBREATHING TECHNIQUE USING THE SCINTILLATION CAMERA. Hisada, Kin-ichi; Hiraki, Tatsunosuke; Mishima, Tsutomu; Matsudaira, Masamichi; Kuranishi, Makoto (Kanazawa Univ., Kanazawa City, Japan). Radioisotopes (Tokyo), 17: 307-10(July 1968). (In Japanese).

Xenon-133-rebreathing technique using the scintillation camera was useful for determining regional pulmonary function in 30 patients with conditions such as large bulla or bronchial asthma suffering dyspnea and cardiac disease. As the method, an anterior or posterior scintiphoto of the lungs was obtained at every 2 minutes from immediately after injection of $^{133}$Xe-solution (1–4 mCi) intravenously. In $^{133}$Xe-rebreathing technique, three phases of lung scintiphotos can be obtained. The first image of serial scintiphotos shows the perfusion phase (0–2 minutes exposure after injection of $^{133}$Xe-solution) of the lung. The second image shows the ventilation phase (exposure time is 3–6 minutes after), and the third image shows the wash-out phase (3 minutes after washed out). In case 3 mCi of $^{133}$Xe is administered, tissue absorption dose is calculated to be 21 ~ 31 millirads at the gonads and 572–593 millirads at the lungs. (auth)

**45303** A METHOD FOR TRANSLATING SCINTIPHOTOS INTO COLOR BY THE APPLICATION OF THE SABATTIER EFFECT. Onai, Yoshio; Tomaru, Teizo; Irifune, Toraji; Uchida, Isao; Tsuya, Akira (Cancer Inst., Tokyo). Radioisotopes (Tokyo), 17: 275-9(July 1968).

A method for making color scintiphotos from the scintillation camera has been reported by Anger, et al. But their method cannot be applied to pictures recorded with a three-lens camera, because images obtained with a six-lens camera must be used in their method. In the method described here, three different patterns obtained simultaneously from original images by the application of the Sabattier effect are superposed on a color film through a red, a green, and a blue filter. Since the reversal image by the application of the Sabattier effect shows a zone of equal density in the original image, a zone of the same color obtained by this method shows the zone of equal density or equal radiation intensity in the original image, and, therefore, this

method may be useful for a semi-quantitative analysis of images from the scintillation camera. The procedure of this method is described in detail with some clinical examples. This method is also applicable for photoscans with continuously varying density. (auth)

**45304** COMPARISON OF THYROID SCINTIGRAMS BETWEEN BY SCANNER AND BY CAMERA. Yasukochi, Hiroshi; Ishikawa, Daiji; Yamazaki, Toshio; Miyamae, Tatsuya; Lin, Sanjin (Tokyo Univ.). Radioisotopes (Tokyo), 17: 294-301(July 1968). (In Japanese).

The most characteristic value of scintillation camera is its high sensitivity compared to that of scanner. Consequently the time needed to get scintigrams is shortened especially in high dose distribution of radioisotopes, just as to have heart pool dynamic scintigrams with one second intervals. Another view point of scintillation camera, the problem of resolution, is discussed on the thyroid scintigrams. Phantom studies are shown in scintigrams both by scanners and cameras using line phantom. The evaluations of the scintigrams by scanner depend on many factors, they are energies selected, crystal size, nature and dose of radioisotopes, representation system and geometry and efficiency of collimators. To have the complete evaluation, the scintigrams must be discussed as a matrix of all of these factors, but in this paper mainly because of its complexity, each factor is discussed separately. On camera the distance between collimators, multiparallel hole and pinhole, is examined. The clinical data are also shown as scintigrams by both apparatuses. As a result, the thyroid scintigrams by camera with pinhole collimator is usually superior to that of scanner in the point of resolution and clinical evaluation. The procedures and time needed are also summarized and in busy clinics the camera is suggested as a more preferable apparatus in thyroid scintigram study. (auth)

**45305** PREPARATION OF ELECTRON SENSITIVE EMULSION PLATES IN THE LABORATORY. Antony, M. (Univ., Strasbourg). Jap. J. Appl. Phys., 7: 1137(Sept. 1968).

A thin coating of gelatin is applied evenly over a clean, dry glass plate. The emulsion is melted at 50°C and spread over the gelatin layer. The emulsion is smoothed by placing a second glass plate with gelatin on the emulsion and shearing the plates with one light stroke. Thus, two plates are prepared with emulsions approximately 25 microns thick. (W.H.K.)

**45306** EXPERIENCE WITH AN IMPROVED STACK MONITOR. Jolly, L. Jr.; Harper, J. A.; Smith, S. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 15: 251-6(Sept. 1968). (DPSPU-66-30-14).

An improved stack monitor for radioiodine and particulate fission products has been developed for a radiochemical separations facility at the Savannah River Plant. The monitor, consisting of a filter and an adsorber in shielded housings, has an average iodine-131 collection efficiency of 84%. Particulate radioactivity is trapped by a paper filter, and radioiodine by activated coconut shell charcoal in the absorber. Each has a separate G-M tube and recording system. Alarms signal high release rates and failures in the monitoring system. When iodine-131 releases are below 50 mCi per day charcoal canisters are kept in service for 7 days. At higher release levels the service period is reduced, since the percentage collected by the primary adsorber decreases with time. Normal monitoring ranges are from 3 mCi to 300 Ci/day for iodine-131 and 3 mCi to 100 Ci/day for particulate fission products. Total release of iodine-131 and particulate fission products from all SRP stacks normally remains well below 100 mCi/day. Iodine-131 stack release values obtained with the improved monitor over 2 years of operation average within 4% of laboratory determinations (by gamma pulse height analyzer). (auth)

**45307** AUTOMATION OF THE PRODUCTION-LINE TESTING OF NUCLEAR DETECTOR PARAMETERS. Csakany, A.; Javor, A.; Vajda, F. (Central Research Inst. for Physics, Budapest). Meres Automat., 14: 112-13(1966). (In Hungarian).

Most of the important characteristics of energy-sensitive nuclear detectors are related to measurable or countable values in specially chosen energy ranges, using the 661-keV line of cesium-137. In order to increase the ease of these measurements, an automatic device was developed to measure the energy resolution, stability and equivalent noise of electronic multipliers and scintillators. Advantage was taken of the fact that the location of the center of gravity of the half of the Gaussian curve is proportional to the standard error. The stability is determined by comparing the peaks of the spectrum with the true positions given by a high-precision pulse generator. The noise measurement involves a standardization of the scale, and pulse counting. The individual characteristics are measured within the following limits: peak stability—0.3 to 10% ± 0.1%; resolution—5 to 15% ± 0.5%. The instrument is able to handle information from 1 to 6 independent channels and may be operated as an automatic, semi-automatic or manual device. (TTT)

**45308** INFLUENCE OF SNOW ON NEUTRON MONITOR INTENSITY. Tanskanen, P. J. (Oulu Univ., Finland). Nature (London), 219: 926-7(Aug. 31, 1968).

The surroundings of a neutron monitor are important in the registration of data, particularly atmospheric pressure, humidity, and temperature. An investigation was made to determine the effect on a roof monitor of snow on the roof. Neutron monitor data from Deep River (Canada), Kiel and Oulu were compared after correction for pressure. It was found that a decrease in intensity occurred at Oulu apparently as a result of sudden snowfall, and removal of snow from the roof caused a sudden change of ~2%. It was estimated that a 20 cm layer of snow above the instrument would correspond to an absorber of thickness 6 to 8 g/cm$^2$. It has been shown that evaporation neutrons from surroundings can contribute at least 5% of the counting rate of a super neutron monitor, and increase of the thickness of an absorbing material can exclude these particles, as well as absorbing cosmic ray nucleons which produce stars in the lead surrounding a proportional counter. (UK)

**45309** JUNCTION DETECTORS. NEW TOOL FOR THE STUDY OF NUCLEAR RADIATIONS. Fettweis, P. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Rev. Quest. Sci., No. 4, 487-517(Oct. 1966). (In French).

The operation of junction detectors is compared with that of ionization chambers, and a review is given of the basic properties of gas and solid ionization chambers. Some basic concepts of solid-state physics, indispensable to the comprehension of the technology of junction detectors, are summarized. The different types of junction detectors and the application of each type are described in some detail. (tr-auth)

**45310** MEASUREMENT OF INTEGRATED FLUXES OF THERMAL NEUTRONS BY MEANS OF GEIGER-MUELLER COUNTERS WITH ACTIVATABLE CATHODES. Darres, Maurice; Picco, Charles (Centre de Physique Atomique et Nucleaire, Toulouse). Radioprotection, 3: 29-38(1968). (In French).

In the case of thermal neutrons, the cylindrical geometry is abandoned in order to adopt cathodes formed by two parallel discs: the flux perturbation is weaker and the electrical characteristics remain good. Cathodes of Cu, Cy, and Au were tested with the thermal neutrons of the Siloette reactor and by a 7-Ci Pu-$\alpha$-Be source. The fluxes were determined by the activation of gold foils (bare or covered with cadmium). For irradiation times below 0.3 times the half-life of the radionuclide produced, integrated fluxes between $4 \times 10^5$ n/cm$^2$ (Dy) and $17 \times 10^{10}$ n/cm$^2$ (Cu) can be measured. These correspond to doses absorbed in soft tissue between 0.25 mrad and 100 rad. (tr-auth)

**45311** PULSE TIMING SYSTEM FOR USE WITH GAMMA RAYS ON Ge(Li) DETECTORS. Chase, Robert L. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 39: 1318-26 (Sept. 1968).

A zero crossing technique has been employed to reduce energy-dependent time errors when detecting gamma rays with Ge(Li) detectors. The timing errors associated with pulse shape variation have been evaluated so that circuit parameters might be chosen to minimize those errors. Results of coincidence measurements using a plastic scintillator and a Ge(Li) detector are presented. Typical results using an 8 cc planar detector are 0.8 nsec fwhm at 2.75 MeV, 2.8 nsec fwhm at 511 keV, and 1.5 nsec variation in coincidence peak position from 500 keV to 2.75 MeV. (auth)

**45312** CALIBRATION OF SPARK CHAMBERS WITH LIGHT. Poelz, G.; Springer, K. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg). Rev. Sci. Instrum., 39: 1388-9 (Sept. 1968).

The generation of artificial sparks by pulsed light in a spark chamber with transparent electrodes for testing and calibrating the chamber is discussed. (B.G.D.)

**45313** AUTOMATIC MONITOR FOR MEASURING ALPHA AND BETA CONTAMINATION OF CLOTHING. Gebauer, H. (Frieseke and Hoepfner GmbH, Erlangen, Ger.); de Ras, E. M. M.; Vaane, J. P. Kerntechnik, 10: 374-7(July 1968). (In German and English).

A compact automatic laundry monitor was developed for measuring alpha and beta contamination in one operation. It is used for monitoring items of clothing worn during work in the hot cells and in the plutonium laboratory. The device is equipped with large area proportional flow counters used as detectors. The attainable detection sensitivity is $0.3 \times 10^{-6}$ μCi/cm$^2$ distributed over a 100 cm$^2$ area for alpha radiation, and $0.2 \times 10^{-6}$ μCi/cm$^2$ distributed over a 100 cm$^2$ area for beta radiation. (auth)

**45314** MEASUREMENT OF THE X RAY SPECTRA BY MEANS OF GERMANIUM SEMICONDUCTOR DETECTORS. Wachsmann, F.; Drexler, G. Magy. Radiol., 20: 194-201(June 1968). (In Hungarian).

The possibilities of the use of germanium semiconductor detectors, drifted with lithium, in the energy-range of 10 to 150 keV are outlined. The spectra obtained by means of such detectors were easily smoothed and the method was very simple with the appropriate apparatus. The spectra of primary radiations filtered in various degree are discussed. The changes of the spectrum of the x ray, if the x ray passed through layers of various thickness, whose substance was identical with that of the body, was demonstrated. (auth)

## *Nuclear Spectroscopic Instrumentation*

**45315** (AAEC/TM-462) THE HIGH RESOLUTION STUDY OF GAMMA RAYS FROM keV NEUTRON CAPTURE. Allen, B. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 31p. Dep.

A Ge(Li) detector and time-of-flight system are used with an on-line computer to measure gamma rays emitted after keV neutron capture. The low efficiency of the Ge(Li) detector necessitates careful optimization of experimental parameters. Conflicting requirements of yield rate and timing resolution are discussed in terms of accelerator performance, target geometry and data-taking methods. The selection of suitable capture targets is considered. (auth)

**45316** (AERE-R-5703) GAMMA-RAY SPECTROMETER SYSTEMS USING LITHIUM DRIFTED GERMANIUM DETECTORS. Gibbons, P. E.; Howes, J. H. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1968. 37p. Dep. CFSTI. UK 6s.

A range of germanium detectors up to 50cc in volume has been developed at A.E.R.E., Harwell. The basic features of these detectors and their operational requirements are described. Operation of these detectors gives rise to some problems which must be solved if their potentials are to be fully and reliably achieved. This has involved the design of various types of cryostats, and the development of low-noise pulse amplifiers which can be matched to a detector to give an optimum response. This work leads to the concept of a spectrometer system, constructed from a basic set of components, designed to meet a specific counting requirement. Several spectrometer systems were built and are described in detail. The degree of resolution obtainable has opened up many new areas of work in gamma spectrometry. Particular examples in radiochemical analysis, fuel-element studies, and nuclear physics are described, and a short account of other applications is given. (auth)

**45317** (BARC-326) STUDIES ON A SPLIT-POLE MAGNETIC SPECTROGRAPH. Viswesvariah, M. N.; Sarma, N. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 40p. Dep.

A first order theory of the performance of a split-pole charged-particle magnetic spectrometer is given. Topics discussed include circular sector magnet, virtual image distance, split sector magnet, straight sector magnet, median plane magnification, momentum dispersion, momentum resolution, lateral magnification, kinematic correction, and variation of momentum resolution with change in source distance. Also, construction details for a split-pole magnetic spectrograph are presented. (W.H.K.)

**45318** (BNWL-SA-2009) AN ANTICOINCIDENCE-SHIELDED Ge(Li) GAMMA-RAY SPECTROMETER AND ITS APPLICATION TO NEUTRON ACTIVATION ANALYSIS. Cooper, J. A.; Ranicitelli, L. A.; Perkins, R. W.; Haller, W. A.; Jackson, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 2, 1968. Contract AT(45-1)-1830. 15p. (CONF-681003-3). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

The design and performance of an anticoincidence-shielded lithium-drifted germanium gamma spectrometer with high efficiency, resolution, and Compton reduction are presented. Also, use of the spectrometer in nondestructive activation analysis is illustrated. (W.H.K.)

**45319** (IA-1166) A THEORETICAL COMPARISON BETWEEN THE TOF AND DAS DIFFRACTION METHODS. Epstein, A.; Shaked, H. (Israel Atomic Energy Commission, Tel Aviv). Dec. 1967. 16p. Dep.

Two neutron diffraction methods, the double-axis spectrometer (DAS) and the time of flight (TOF) are compared. The experimental apparatus and resolution are discussed. (auth)

**45320** SEMICONDUCTOR MEASUREMENTS OF FALLOUT. Winiger, P.; Huber, O.; Halter, J. (Univ., Fribourg, Switzerland). Helv. Phys. Acta, 41: 645-9(Aug. 15, 1968). (In German).

Two $\gamma$-ray spectra of recent fission products, measured by a NaI well-type crystal and a Ge(Li) drifted diode are compared. The high energy resolution of the small semi-conductor compensates nearly its low detection efficiency and allows a much more reliable analysis of complex spectra within the monitoring of radioactivity. An example of an analysis is given. (auth)

**45321** PREPARATION OF THIN FILMS OF MYLAR. Sinha, B. K.; Bhattacharyya, R. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Instrum. Methods, 64: 107-8(Sept. 1, 1968).

A method for preparing mylar films of thicknesses down to 200 $\mu g/cm^2$ is described starting from any commercial variety of mylar. (auth)

**45322** LOW BACKGROUND DUAL PHOSPHOR BETA-RAY SPECTROMETER. Hiramoto, T.; Tanaka, E. (National Inst. of Radiological Sciences, Chiba, Japan). Nucl. Instrum. Methods, 64: 35-9(Sept. 1, 1968).

A $\beta$-ray scintillation spectrometer suitable for low level samples has been constructed. The detector consists of a thick $CaF_2(Eu)$ and a thin anthracene phosphor which are viewed by a single photomultiplier. The sum signals of output pulses from both the phosphors are gated by the anthracene signals selected by means of pulse shape discrimination. The detector has an effective diameter of 3.6 cm, and the background counting rate is about 1.7 cpm for the energy range from 0.1 to 4 MeV, in a heavy shield. The relation between the usable energy range and the thickness of the anthracene is described with reference to the pulse shape discrimination. (auth)

**45323** OPTICAL DIAGRAMS OF PRISM SPECTROMETERS WITH QUADRUPOLE LENSES. Shpak, E. V.; Yavor, S. Ya.; Lyubchik, Ya. G. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 64: 97-103(Sept. 1, 1968).

Optical diagrams of prism spectrometers for charged particles employing single quadrupole lenses or the corresponding doublets as collimating and focusing lenses are discussed. The parameters of spectrometers with an astigmatic beam at the entrance to and exit from the prism are considered. Conditions for the compensation of the third-order spherical aberration of quadrupole lens systems in prism spectrometers by means of octupoles are determined. (auth)

**45324** METHOD TO INCREASE THE LUMINOSITY OF A MAGNETIC SPECTROMETER. Shibata, T.; Taya, S.; Yoshizawa, Y. (Osaka Univ.). Nucl. Instrum. Methods, 64: 29-34(Sept. 1, 1968).

An attempt was made to increase the transmission of the usual magnetic spectrometer at high resolution (<0.1%) by using a weak azimuthally-variable magnetic-field. Calculations were made for the semicircular and the double focusing spectrometer. Experiments were performed by using a conventional double focusing beta-ray spectrometer. The correction field was produced by a coil at the center of the orbit between the source and the detector. The transmission is about 10 times increased at a resolution of 0.06 to 0.09%. It was found from the photographic measurement that the vertical defocusing effect is negligibly small. In addition, the multi-strip source technique developed by Bergkvist was applied in orders to enlarge the effective source area. From both methods, we obtained a luminosity about 100 times larger than that of the ordinary double focusing spectrometer. (auth)

**45325** TIME DEPENDENT FILTER AS PULSE FORMER FOR THE NUCLEAR RADIATION SPECTROMETER. Schuster, H.-J. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 63: 342-4(Aug. 15, 1968). (In German).

A time dependent filter for use as the pulse forming circuit following a charge sensitive preamplifier is described. It is designed to improve the signal-to-noise ratio and the time resolution for spectroscopy of nuclear radiations. (auth)

**45326** REDUCTION OF TIME SPREAD IN ON-LINE FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Adam, Andras; Jeki, Laszlo; Palla, Gabriella. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 231-5(1968). (In Hungarian).

A method developed for the reduction of the time spread, which markedly impairs the time resolution in on-line fast neutron time-of-flight spectrometers, is described. By earlier efforts the uncertainty of time due to the continuous pulse height distribution of monoenergetic neutrons was reduced electronically and the time resolution improved from $2\tau = 2.95$ nsec to $2\tau = 1.8$ nsec. With the method presented, in which the time spread

of the $\alpha$-signals is also taken into account, a time resolution of $2\tau = 1.03$ nsec and a simultaneous increase in counting efficiency of the neutron detector can be achieved. (auth)

**45327** PULSED LINAC NEUTRON DIFFRACTION. Moore, M. J. (General Electric Corp., Schenectady, N. Y.); Kasper, J. S.; Menzel, J. H. Nature (London), 219: 848-9(Aug. 24, 1968).

A new method of obtaining neutron diffraction patterns from polycrystalline specimens using a pulsed linear accelerator as a neutron source, in conjunction with a time-of-flight detection system, is described. The normal pulsed operation of the accelerator obviates the need for an elaborate and expensive chopper. The flux of usable neutrons provided by an accelerator such as the Rensselaer LINAC is quite high, as judged by the satisfactory diffraction pattern obtained for an NiO specimen. A block diagram of the system used is shown. The LINAC electron pulse strikes a water-cooled tantalum target, producing a high flux of gamma rays, and a $(\gamma,n)$ reaction in the target then gives high energy neutrons with isotropic distribution. Liquid $N_2$ cooled polyethylene is used as moderator. Full experimental details are given, including shielding, for the study of NiO. The two outstanding characteristics of the LINAC diffraction pattern are the large number of reflections and the progressive broadening of the peaks with increasing wavelength; the latter apparent disadvantage was not as serious as had been anticipated. Accuracy of measurements is limited by the accuracy of measurement of the flight path. It would appear that the most worthwhile exploitation of the technique would be in special applications such as high pressure experiments and high or low temperature studies, where the sample must be contained in a thick-walled vessel, or be surrounded by other materials. It may also be possible to make use of the high flux of fast neutrons for studies of highly absorbing materials and for obtaining more accurate values of lattice constants and thermal parameters. (UK)

**45328** NONDESTRUCTIVE TESTING APPARATUS OF IRRADIATED FUEL ELEMENTS BY GAMMA SCANNING. Hauser, G. P. Energ. Nucl. (Paris), 10: 257-65(June 1968). (In French).

Gamma spectroscopy equipment for nondestructive testing of irradiated fuel elements by gamma scanning, used to determine the relative irradiation curves along a fuel channel, is described. It is designed to perform dimensional measurements and to show actual uranium defects on a qualitative and sometimes quantitative basis. Results are given and the sensitivity of the method is discussed. (auth)

**45329** COLD-NEUTRON SCATTERING EXPERIMENTS ON CYCLIC HYDROCARBONS WITH A ROTATING-CRYSTAL SPECTROMETER. De Graaf, Leendert Adam. Delft, Netherlands, Technische Hogeschool, 1968. 111p.

Thesis.

The design, construction, and performance of a rotating-crystal spectrometer for cold-neutron scattering experiments with cyclic hydrocarbons, especially cyclohexane, cyclopentane, and methylcyclohexane, are discussed. The theoretical background of such experiments are examined and experimental details are given. The experimental results from the investigated hydrocarbons are analyzed. (B.G.D.)

**45330** FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER USED WITH THE KARLSRUHE ISOCHRONOUS CYCLOTRON. Cierjacks, S.; Duelli, B.; orti, P.; Kopsch, D.; Kropp, L.; Loesel, M.; Nebe, J.; Schweickert, H.; Unseld, H. (Kernforschungszentrum, Karlsruhe, Ger.). Rev. Sci. Instrum., 39: 1279-88(Sept. 1968).

A high resolution, fast neutron, time-of-flight spectrometer used for neutron energies between about several hundred kiloelectron volts and 30 MeV is described. A 1 nsec neutron pulse occurring with a repetition rate of 20 kc is obtained with a novel bunching deflection system operating on the internal beam of the fixed energy Karlsruhe isochronous cyclotron. By the timing of the neutrons over a 57 m flight path a resolution of 0.025 nsec/m at optimum was obtained. Detector counts are accumulated in a $2 \times 8000$ channel time analyzer system with 1 nsec channel width. A planned flight path of 180 m and an increase of the repetition rate from 20 kc at present to 200 kc is expected to provide further improvements of the spectrometer. (auth)

**45331** BETA-RAY SPECTROSCOPY OF RADIOACTIVE FALLOUT. Allkofer, O. C.; Simon, M. (Univ., Kiel). Kerntechnik, 10: 378-83(July 1968). (In German and English).

The design and operation of a beta-ray spectrometer with two lithium-drifted silicon semiconductor detectors in stack assembly are described. Examples are given illustrating the rational application of this spectrometer to nuclide analysis of fallout samples. The examples given relate to the strontium isotopes $^{90}Sr$ and $^{89}Sr$, the ruthenium isotopes $^{103}Ru$ and $^{106}Ru$, and the transuranium nuclide $^{239}Np$. (auth)

### *High Energy Physics Instrumentation*

**45332** (ANL-Trans-640) DETERMINATION OF THE DIRECTION OF THE NEUTRAL HIGH-ENERGY PARTICLE BEAM OF THE JINR SYNCHROPHASOTRON BY CONVERSION PAIRS AND THE $\gamma$-QUANTA SPECTRUM IN THIS BEAM. Beslin, T.; Vishnevskii, V.; Gavrilas, M.; Constantinescu, A.; Mihul, A.; Moroz, V.; Nikitin, A.; Troyan, Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy).

Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report JINR-P-2916. 6p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 21: 3244. (W.H.K.)

**45333** (JINR-P3-3957) MULTILAYER SPARK CHAMBER FOR FISSION FRAGMENTS DETECTION. Ryabov, Yu. V.; So Dhon Sik (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 12p. (In Russian). Dep.

A multilayer and multiwire spark chamber of a corona type with a plane cathode and the area of the fissioning layer being $\approx 2000$ $cm^2$ has been developed and investigated. It is shown that the efficiency of the fission fragment detection can reach 60% at the detection efficiency of $\alpha$-particles being $\approx 10\%$. The chamber is used for the time-of-flight measurements of the fission cross sections by the pulsed neutron spectrometer of the JINR. (auth)

**45334** (JINR-P10-3910) CHECKING OF THE PICTURE PROCESSING FROM SPARK CHAMBERS. Bystritski, I.; Legar, F.; Chekh, Ya.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 18p. (In Russian). Dep.

The errors, appearing while scanning the pictures from spark chambers by using semi-automatic devices, are being considered. Statistical errors of the operator are measured and the systematic errors are estimated. A method is described by which statistical errors can be determined. It has been proven that the systematic errors can be reduced if the experimental material is scanned in parts by direct and mirror images. The measurement results are listed in tables and graphs. (auth)

**45335** (JINR-P13-3918) ON THE DETERMINATION OF RECORDING EFFICIENCY OF $\gamma$-QUANTA IN THE XENON BUBBLE CHAMBER. Okhrimenko, L. S.; Slovinskii, B.; Strugal'skii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 10p. (In Russian). Dep.

A method is presented for the determination of $\gamma$-quanta statistical weights, which were recorded in the xenon bubble chamber taking into account a chosen permissible error in the measurement of their energies ($E_\gamma$) according to previously developed methods. (auth)

**45336** SPARK CHAMBERS WITH WIDE-GAP AND STREAMER CHAMBERS. Sittel, Robert. Sci. Progr.-Nature, No. 3399, 258-64(July 1968). (In French).

A resumé of the development and operation of spark chambers with wide spacing between plates and streamer chambers is given. Photographs are given showing the wide-gap spark chamber and the streamer chamber. Also particle trajectories from these spark chambers are shown. Earlier detectors, particularly the bubble chamber, are also briefly reviewed. (J.F.P.)

## Radiation Dosimeters

*Refer also to abstracts 45274 and 45943.*

**45337** (NYO-3510-5) BIOLOGICAL AND CLINICAL DOSIMETRY. Annual Progress Report, July 1, 1967-June 30, 1968. Laughlin, John S. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-3510. 52p. Dep. CFSTI.

A highly accurate output monitor system utilizing a current transformer was developed for the 30 nanosecond pulse field emission electron source. Charge and energy fluence were determined as a function of distance from the source. Dose rate dependence was studied for rates up to $3 \times 10^{12}$ Rads/sec for LiF and $CaF_2$:Mn thermoluminescent dosimeters. Depth dose measurements were made in polystyrene using microtomed teflon $CaF_2$:Mn dosimeters. Preliminary experiments were performed with the dual channel 2 nanosecond pulse field emission electron source. The results of participation in the National Bureau of Standards (NBS) electron beam dosimetry uniformity study are discussed. An ionization chamber has been fabricated from Shonka tissue equivalent plastic for measurement of total tissue dose and depth dose distributions produced by fast neutrons. A matrix of lithium drifted diodes consisting of a single square diode 1.6 cm on a side and 3 mm depletion depth was made to yield incident beta particle position within 3 $mm^2$. Measurements of matrix elec-

trical characteristics are presented. Miniature p–n junction silicon diodes were produced for eventual in vivo applications. The use of ultrasonic bonding techniques facilitated the attachment of 0.005" aluminum electrical lead wires which are expected to minimize the effects of scattering from lead wires on diode response in irradiated media. (auth)

**45338** RADIATION DOSIMETRY. Second Edition. Volume 1. Fundamentals. Attix, Frank H.; Roesch, William C. (eds.). New York, Academic Press, 1968. 418p. $19.50; 182s.

The fundamentals of radiation physics and dosimetry are discussed. Topics include basic concepts of dosimetry, microscopic energy distribution in irradiated matter, x-ray and gamma-ray interactions, charged-particle interactions, mathematical theory of radiation fields, neutron interactions and penetration in tissue, ionization and cavity-chamber theory. (B.G.D.)

**45339** THEORETICAL INTERPRETATION OF DOSE AND DOSE-RATE DEPENDENCES OF THERMOLUMINESCENT DOSIMETER. Shiragai, Akihiro (National Inst. of Radiological Sciences, Chiba, Japan). Jap. J. Appl. Phys., 7: 1101-4 (Sept. 1968).

The properties of thermoluminescent dosimeter are investigated by the theoretical interpretation of the radiothermoluminescent phenomenon of the phosphors. The radiothermoluminescence is interpreted more inclusively if the creation of thermoluminescent traps by irradiation and the fading during irradiation are taken into account. The dependences of the thermoluminescence light sum (the response of thermoluminescent dosimeter) on dose, dose rate and irradiation time are qualitatively described by the first order kinetics model of monoenergetic electron traps. The two examples are discussed. The conclusions deduced from the model are found to be in good agreement with the experimental results. (auth)

**45340** FACTORS AFFECTING THE MEASUREMENT OF THE EXTINCTION COEFFICIENT OF $Fe^{3+}$ IONS IN A FRICKE DOSIMETER SOLUTION. Bryant, T. H. E.; Ridler, T. P. (Middlesex Hospital Medical School, London). Health Phys., 15: 263-8(Sept. 1968).

Recently published values of the molar extinction coefficient $\epsilon$ of $Fe^{3+}$ ions in 0.8N $H_2SO_4$ measured in the 305 m$\mu$ region differ by as much as 6%. The values of $\epsilon$ obtained using the same set of solutions and different spectrophotometers show a maximum difference of 9%. Possible sources of error in the measurement of $\epsilon$ were investigated experimentally, and methods of reducing the error are suggested. The most probable value of $\epsilon$ at 305 m$\mu$ is assumed to be 2197 l $moles^{-1}$ $cm^{-1}$. (auth) (UK)

**45341** PHOTON COUNTER FOR THE MEASUREMENT OF THERMOLUMINESCENCE. Schneider, R. H.; Kirk, W. P.; Steiner, J. F. Jr.; Rechen, H. J. L. (National Center for Radiological Health, Rockville, Md.). Rev. Sci. Instrum., 39: 1369-71(Sept. 1968).

A photon counter consisting of photomultiplier section and amplifier, discriminator, and scaler–timer for measuring thermoluminescence of various crystals is described. (B.G.D.)

## Radiometric Instruments

**45342** CHOICE OF THE OPTIMUM SIZE OF DEVICES FOR CONTINUOUS DENSITY MEASUREMENTS BY GAMMA-RAY TRANSMISSION TECHNIQUE. Lemke, K. (Technische Hochschule, Ilmenau, Ger). Isotopenpraxis, 4: 95-9(Mar. 1968). (In German).

Starting from the necessary accuracy and the required local resolution, theoretical considerations about the optimum design of devices using gamma-radiation attenuation for continuous measurements of volume density are made. The concepts of statistical resolution and local resolution are defined. Limits for the selection of the optimum thickness of the material under test or of the most favorable radionuclide, respectively, and of the detector length result from investigations of sensitivity and statistical and local resolution. The maximum time constant of the ratemeter circuit and the source activity are calculated. The accuracy of the electronic measurement assembly is estimated. (auth)

**45343** DETERMINATION OF THE SILVER MASS PER UNIT AREA ON FILMS BY X-RAY FLUORESCENCE EXCITATION. Brunner, G. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 4: 99-103(Mar. 1968). (In German).

The sensitivity of the determination of silver mass per unit area for preparation of photographic film has been calculated essentially by deriving a general formula for the x-ray saturation intensity of the massive sample volume. The influence of film support has been determined by comparison of the Thomson scattering and the x-ray excitation cross-sections. According to this 100 $\mu$m of cellon support is found to be equivalent to about 0.5 gm $m^{-2}$ Ag. As to the influence of moisture of freshly poured emulsions it was found that the content of water corresponding to the silver concentration usually employed of about p = 50 g/l exerts influence on the measuring of about 8 percent as compared with that for dry film. (auth)

## Miscellaneous Instruments and Components

*Refer also to abstracts 46731 and 47040.*

**45344** (AAEC/E–191) COMPUTER-CONTROLLED DIFFRACTOMETER. Ellis, P. J.; Pryor, A. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1968. 143p. Dep.

A computer-controlled neutron diffractometer is described for the collection of Bragg intensities from a single crystal. The computer is a PDP-8 with a store of 4096 12-bit words. The diffractometer is a 4-circle instrument with the axes driven by pulsed stepping-motors, while axis movement is checked by light-beam markers. The programs include procedures for centering reflections, rotating about the scattering vector, calculating the setting angles in the bisecting and parallel positions, scanning over diffraction peaks, measuring backgrounds and generating ranges of Miller indices. Two similar diffractometers may be operated simultaneously. (auth)

**45345** (AERE-R–5676) ACCURACY OF OPEN CHANNEL FLOW MEASUREMENTS USING RADIOACTIVE TRACERS. Smith, D. B.; Wearn, P. L.; Parsons, T. V. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). June 1968. 13p. Dep. CFSTI. UK 2s. 6d.

Three radioisotope techniques can be used for flow measurement. These are the constant rate injection method, the sudden injection method with continuous sampling of the tracer, and the sudden injection method with integrated in situ measurement of tracer (the total count method). The continuous sampling method is considered to be the most suitable for accurate and reliable river flow measurement. This technique is of particular value for the calibration and checking of hydraulic structures such as weirs and flumes. The series of measurements discussed were undertaken to examine and improve the accuracy of the technique, using a variable flow recirculating flume in which the flow was measured volumetrically. (auth)

**45346** (AERE-R–5698) THE DIDO WHITE BEAM SCATTERING APPARATUS. Beirne, T. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1968. 14p. Dep. CFSTI.

A "white beam" apparatus for studying neutron scattering in magnetic materials by using "small angle scattering" techniques is described. The apparatus enables the spin wave contribution to the scattering to be isolated by comparing the numbers of scattered neutrons whilst the specimen is saturated by a magnetic field applied first parallel and then perpendicular to the scattering vector. The scattered neutrons are detected by five $BF_3$ counters which can be positioned from –10° to 45° about the incident beam. Cryostats and furnaces are described which permit the specimen temperature to vary in the range 10°K to 1100°K. (auth)

**45347** (AERE-Trans–1095) THERMOCOUPLES FOR HIGH-TEMPERATURE MEASUREMENT. Villamayor, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated by J. B. Sykes and B. R. Skelding (Atomic Energy Research Establishment, Harwell, Eng.), from report CEA-R–3182. 76p. Dep. CFSTI. UK 19s.

Thesis. Submitted to Univ. of Lyon.

A study of the behaviour of pure tungsten/tungsten, 26% rhenium and tungsten, 5% rhenium/tungsten, 26% rhenium thermocouples made in France and designed to monitor the temperature in nuclear reactors, is described. The general properties of these thermocouples were determined in out-of-pile studies. An attempt was made to define errors of measurement resulting from conditions of use, by finding the response time, drift as a function of time, and the effect of thermal shock. In order to ascertain changes in thermocouples under irradiation in an extended temperature range an in-pile study was undertaken, and the results of this study are described. Effects caused by nuclear transmutations led to a proposal for a new type of thermocouple of molybdenum/niobium alloys. (auth)

**45348** (APDA–223) FEASIBILITY STUDIES FOR AN ACOUSTIC IMAGE CONVERSION SYSTEM. Barkhoudarian, S. (Atomic

Power Development Associates, Inc., Detroit, Mich.). July 1968. Contract AT(11-1)-865. 85p. Dep. CFSTI.

To demonstrate the feasibility of imaging with an acoustic conversion tube at high temperatures, as well as the feasibility of transceiving in the pulse-echo mode, pulse units including a transmitter, receiver, amplifier, and control circuit were designed and built. Tests were conducted in both water and silicone oil using 2-MHz, 2-inch-diameter, X-cut, single quartz crystal transceivers of various electrode designs. The results proved that an acoustic conversion tube can image in a transceiving mode and that the tube can image at temperatures at least as high as 425°F, which was the peripheral temperature limit of the experiment. (auth)

**45349** (CERN-Trans-68-5) TRANSFORMATEUR A CABLES POUR LE FORMAGE D'IMPULSIONS DE HAUTE TENSION D'UNE DUREE DE QUELQUES NANOSECONDES. (Cable Transformer for the Formation of High-Voltage Pulses of Several Nanoseconds Duration). Nasibov, A. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated into French by A. Golovanoff (CERN, Geneva), from Preprint No. 150. 12p. (In French). Dep.

The principal calculation elements of the parameters of a cable pulsed transformer are given. The possibility of using the transformer for the formation of high voltage pulses on the order of one nanosecond is discussed. (J.S.R.)

**45350** (EIR-136) NANOSECOND BIPOLAR PULSE AMPLIFIER STAGE. Behringer, K.; Dubochet, E. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). June 1968. 7p. (CONF-680906-2). Dep.

From International Symposium on Nuclear Electronics, Versailles, France.

A feedback pulse amplifier stage operating in the nanosecond region is briefly described. It is built up in a symmetrical configuration and is suitable for the amplification of fast bipolar pulses. With the use of 2 GHz transistor types a rise time of 0.7 ns at a gain of 4 could be achieved. (auth)

**45351** (JUL-505-RC) EINE EINFACHE AUTOMATIK FUER MESSUNGEN AM MASSENSPEKTROMETER MIT WIEDERHOLTEM SCAN UND WAEHLBARER ZYKLENZAHL. (A Single Automatic Device for Measurements on the Mass Spectrometer with Scan Repeat and Optional Cycle Number). Hess, Bernhard (Kernforschungsanlage, Juelich (West Germany). Institut fuer Radiochemie). Dec. 1967. 3p. (In German). Dep.

Quantitative routine measurements of isotopic ratios require a repeat scan in a limited mass number range. A simple expansion of the scan device of a commercial mass spectrometer is described which makes it possible to select the desired scan repeats and to carry out the measurement automatically. A circuit diagram of the device is given. (J.S.R.)

**45352** (JUL-539-PP) A 2MA METAL-TO-METAL SWITCH WITH 0.1 μsec JITTER TIME. Dokopoulos, P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). June 1968. 20p. Dep.

A foil switch of plane configuration with low inductance and low resistance is described. An exploding aluminum foil drives the two switch electrodes together; the insulation is sheared and a metal-to-metal contact results. Clamp and start switching have been possible on circuits having a voltage up to 60 kV, a frequency up to 300 kHz and a current up to 2 MA. The delay is 3.4 ± 0.1 μsec for a 2 MA current rating and a 0.4 mm polythene insulation; decreasing the current rating or the insulation thickness, decreases the delay too. High current (MA) pulses of a few μsec risetime and more than 1 msec decay time with less than 2% oscillations have been produced in clamped circuits with small inductive loads (20 nH). An analysis of the current-time dependence after clamping an inductance with such a switch is given. The theoretical results have been found to be in accordance with the experimental data. (auth)

**45353** (LA-3957) TV TEST PACKAGE. Hopkins, J. C.; Thurston, R. S.; Martin, J. T. (comps.) (Los Alamos Scientific Lab., N. Mex.). June 1, 1968. Contract W-7405-eng-36. 35p. Dep. CFSTI.

Several experimental packages were included on an NTS event to obtain qualitative information on spurious EM signals 16 to 20 msec after detonation. In addition a series of cryogenic experiments were performed to demonstrate the feasibility and simplicity of cooling underground instrument packages from a supply of liquid nitrogen. (auth)

**45354** (RFP-Trans-35) PROCEDURE AND ARRANGEMENT FOR THE DETECTION OF IONS IN MASS SPECTROMETERS. Haenlein, Walter; Boehm, Hans. Translated from German Patent 1,231,037. 6p. Dep. CFSTI.

A method for detecting ions in the evacuated collecting space of a mass spectrometer by means of a secondary electron multiplier is described. The ions are collected by a foil which is scanned by an electron beam. The reflected electron beam is amplified in the secondary electron multiplier. (W.H.K.)

**45355** (RT/EL-(67)14) COORDINAMENTO DELLE ATTIVITA NEL CAMPO DELL'ELETTRONICA E DELLA STRUMENTAZIONE. RAPPORTO N.2: AUTOMAZIONE E CONTROLLO. (Coordination of Activities in the Field of Electronics and Instrumentation. Report No. 2: Automation and Control). Rispoli, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 114p. (In Italian). Dep.

A series of meetings were held to coordinate work and research at Italian laboratories on the automation of nuclear processes and experiments. Papers presented reviewed the work at Casaccia, Frascati, Bologna, and the Ionizing Gas Laboratory. Summaries were given of papers published on optimum synthesis method for a threshold element in the presence of noise, electronic complexes with modular structure for the automation of nuclear experiments, adaptive threshold elements: iterative procedure with variable δ, adaptive elements, analog multipliers, and automatic scanner for nuclear emulsions. Three papers were presented in full, and these have been distributed under the report numbers RT/EL-(67)11, RT/EL-(67)12, and RT/EL(67)13. (J.S.R.)

**45356** (TID-24190, pp 257-300) METEOROLOGICAL INSTRUMENTS FOR USE IN THE ATOMIC ENERGY INDUSTRY. Moses, Harry (Argonne National Lab., Ill.).

A broad survey of meteorological instruments required for the nuclear energy industry is presented. These include instruments for measuring wind speed, temperature, humidity, pressure, and diffusion, and solar and terrestrial radiation, which are used to evaluate sites for nuclear installations. Details are given on the operating characteristics of specific instruments and auxiliary instrumentation equipment. (L.C.L.)

**45357** (UCRL-50007-68-1) HAZARDS CONTROL PROGRESS REPORT NO. 30, JANUARY-APRIL 1968. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 37p. Dep. CFSTI.

Topics included in the hazards control report were air sampler arrays for close-in monitoring during underground nuclear testing, particle size distributions as a function of time within artificially produced clouds, detection of argon-41 in environmental air using gamma spectroscopy, effect of smoke on the formation and stability of high expansion foam, smokes from smoldering and burning materials, monthly summaries of lower atmospheric temperature lapse, and coatings and metals in ductwork environments. (B.G.D.)

**45358** METHOD OF OBTAINING X-RAY INTERFERENCE PATTERNS. Spielberg, Nathan (to North American Philips Co., Inc.). U. S. Patent 3,393,314. July 16, 1968. Filed Sept. 8, 1967.

A method of obtaining an x-ray interference pattern is described in which a monochromatic coherent beam of x-rays is incident upon a first relatively thick, highly perfect crystal exhibiting the Borrmann effect. Two rays are diffracted by the crystal at least one of which is allowed to impinge upon a second such crystal exhibiting the Borrmann effect. Two rays are diffracted by the latter crystal, one of which intersects the first ray at a small controllable angle after it is suitably deviated by a small amount from its original direction by either total reflection or by refraction. Material inserted in the path of one of the intersecting rays causes a phase displacement thereof relative to the other intersecting ray with the consequence that interference occurs at the point of intersection of the two rays. (auth)

**45359** A SLITLESS ION SOURCE IN A SMALL MASS SPECTROMETER FOR ISOTOPIC ANALYSIS OF HYDROGEN IN THE NATURAL RANGE OF DEUTERIUM CONCENTRATION. Bigl, F. (Institut fuer Stabile Isotope, Leipzig). Isotopenpraxis, 4: 104-9 (Mar. 1968). (In German).

The principal design and function of a small mass spectrometer provided with a slitless ion source, for determining the deuterium content over the range of natural deuterium abundance with an accuracy of about 0.2 per cent, are described. (auth)

**45360** PEAK INTEGRATION WITH BACKGROUND SUBTRACTION USING AN ON-LINE PROGRAMMED DESK CALCULATOR. Algranati, M.; Bernstein, D.; Birk, M.; Vager, Z. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Instrum. Methods, 64: 104-6(Sept. 1, 1968).

An interface between a programmable desk calculator and a multichannel pulse height analyzer is described. Peak integration with background subtraction is performed on-line, approximating the background curve by a straight line defined by two manually adjustable points which appear intensified on the screen of the analyzer. (auth)

**45361** FAST PULSE-dc INTEGRATOR. Menke, J. L. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods, 64: 61-8(Sept. 1, 1968).

This fast pulse-dc integrator accepts pulses from dc to less than 20 ns width, over an input dynamic range of 400 : 1 in amplitude (1 mV minimum) without range switching. The integral linearity (maximum absolute error as fraction of full scale) is 0.1 ppM at constant pulse height, 0.2% at constant pulse width. Any reading is accurate to within 2%. Temperature compensation and dc feedback ensure stability of operation. A fast voltage-to-current converter stable to 0.002% of full scale current provides the charge for capacitor storage. (auth)

**45362** SIMPLE ARRANGEMENT FOR THE ACQUISITION OF BIDIMENSIONAL DATA. Bilwes-Bourotte, B. (CRN, Strasbourg); Bilwes, R.; Gerard, C. Nucl. Instrum. Methods, 64: 93-6 (Sept. 1, 1968). (In French).

A bidimensional data acquisition system on paper with two buffer memories is described and dead time losses are calculated as a function of the counting rate. (auth)

**45363** NEUTRON POLARIMETER WITH HIGH ENERGY RESOLUTION. Sieminski, M.; Wilhelmi, Z.; Zych, W.; Zupranski, P. (Inst. of Nuclear Research, Warsaw. Univ., Warsaw). Nucl. Instrum. Methods, 64: 77-9(Sept. 1, 1968).

A new type of neutron polarimeter utilizing the $(n,\alpha)$ scattering as polarization analyzer is described. The energy resolution obtained for 14-MeV neutrons amounts to about 14%. (auth)

**45364** GATED LINEAR CHAIN. Visentin, R. (CNEN, Rome). Nucl. Instrum. Methods, 64: 21-5(Sept. 1, 1968).

The linear chain described here has been studied to process positive current pulses. The chain can be used as a fast linear gate, when timing and shape information of the pulses have to be preserved, allowing further processing at high repetition rates (up to 20 Mc/sec), or it can be used as a gated integrator with a short dead time. The gate, which is essentially a current transducer, exhibits a linear response with pulses whose amplitude is ranging from ≈0 to about 6 V, with a linearity better than 1%. The pedestal amplitude can be minimized to less than 0.5 mA without affecting the opening and closing times of the gate (≈6 ns for 90% transmission of total charge). The signal feed-through is less than 20 mV at an input signal of ≈14 V (rise time less than 1 ns). (auth)

**45365** ETCHED MANGANIN GAGE (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1756).

1 drawing).

An etched, non-inductive manganin gage used to measure shock pressure in a high noise environment such as those containing radiation and electromagnetic effects, is described. The gage measures shocks with amplitudes ranging from 1 to 50 kilobars and durations of several $\mu$ sec. Associated electronics provide a frequency response of 15 MHz through a 50 Ω coaxial cable several thousand ft. long. (For details see TID-4100 Suppl. 47) (F.S.)

**45366** TIME-SAMPLING AMPLIFIER (Engineering Materials). (California Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1754).

2 drawings.

A time-sampling amplifier is described which employs a logic timing approach to provide excellent spectral resolution at low and high counting rates. Active, time-constant switching gates provide low attenuation during time sampling and rapid base-line restoration after time sampling. The amplifier is used in $\alpha$ spectroscopy. Low-rate $\alpha$ resolution approaching 14 keV with $^{244}$Cm is possible and ~18 keV can be obtained at rates approaching 15,000 c/sec. Spectral shift of <0.05% was maintained. (For details see TID-4100 Suppl. 47) (F.S.)

**45367** SUPERCONDUCTING GRAVIMETER. Prothero, W. A. Jr.; Goodkind, J. M. (Univ. of California, San Diego, La Jolla). Rev. Sci. Instrum., 39: 1257-62(Sept. 1968).

A gravimeter is constructed which uses the near perfect stability of superconducting persistent currents to make it a device with exceptional stability. A superconducting sphere is levitated in the magnetic field generated by two superconducting coils. Changes in gravitational or inertial forces in the vertical direction are measured as changes in the vertical position of the sphere or as changes in a feedback force, independent of the primary supporting force, which holds the sphere in a fixed position. In its present state of development the instrument produces data which, when compared to calculated earth tides, set an upper limit on the drift rate of ±6 parts in $10^9$ of g/day. Several possible sources of drift are discussed. (auth)

**45368** STUDY AND DEVELOPMENT OF AN AUTOMATIC RECORDER OF THE FREQUENCY VARIATIONS OF THE RESONANCES OF THE EARTH-IONOSPHERE CAVITY. Benoit, Clara. Ann. Telecommun., 22: 302-20(Nov.-Dec. 1967). (In French).

An apparatus is presented which makes it possible to follow automatically the frequency variation of the resonance fundamental mode of the earth-ionosphere cavity. A study of the phenomenon is made so as to define the analysis conditions. The analyzer is composed of an ensemble of narrow filters which are followed by an integration system. A selector makes it possible to determine the channel corresponding to the frequency of the maximum and to reset to zero the integration capacities. The frequency variations of recording units made at Chambon-la-Foret with the aid of a fluxmeter are given. (tr-auth)

**45369** DIGITAL TIME INTERVALOMETER. Nutt, Ronald (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 39: 1342-5(Sept. 1968).

A digital time intervalometer was developed for measuring time intervals of 1 msec or less with a time resolution of ~200 psec. The start signal can be delayed from 50 nsec to the full range of ~1msec. The range of the instrument is independent of the selected delay and can be set to cover intervals from 100 nsec to ~1 msec. The instrument is unique in that analog time expansion is used to measure very accurately the time phase between a 20 MHz oscillator and the start and stop signals. (auth)

**45370** HIGH IMPEDANCE LANGMUIR PROBES. Schmidt, J. A. (Univ. of Wisconsin, Madison). Rev. Sci. Instrum., 39: 1297-9(Sept. 1968).

The operating characteristics and limitations of high impedance resistive probes are discussed. A new high impedance probe employing capacitive coupling to detect plasma floating potential is described. The advantages of capacitive coupling for increasing the input impedance, reducing the size, and broadening the bandwidth are illustrated. A typical measurement is described which illustrates some of the advantages of the capacitive coupled probe for measurements of plasma properties in a toroidal octupole. (auth)

**45371** SYSTEM FOR IDENTIFYING CHANNELS OF A PULSE ANALYZER MEMORY DATA DISPLAY. Hoffswell, Robert A. (Univ. of Illinois, Urbana). Rev. Sci. Instrum., 39: 1377(Sept. 1968).

In the display mode of most analyzers, the time required for a display cycle is constant. During this time (t) there will be N address advance pulses in the analyzer memory control and N channels displayed. If in the time period after the start and before the end of a display cycle a beam-intensifying pulse is provided to the display cathode ray tube (CRT), an intensified channel will appear in the analyzer memory data display. This assumes the intensifying pulse to be less than t/N sec wide so that only one channel is intensified. The number of address advance pulses counted by a standard decimal counter in the time period preceding the intensification pulse will correspond to the address of the intensified channel. The intensification process may be repeated during each analyzer display cycle so that the brightness of the identified channel is maintained in the display. However, the display time of the address advance pulse counter must be long enough to permit visual readout. Block and pulse timing diagrams of a typical channel identification system are shown. A simple circuit based on the system described was constructed and used extensively with a TMC 4096 analyzer for the identification of channels within both one and two parameter data displays. (B.G.D.)

**45372** TRANSFORMER COUPLING FOR THE CONTINUOUS CHANNEL ELECTRON MULTIPLIER. Lewis, R. N.; Van Loon, L. S.; Mayer, T. A.; Berkowitz, J. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 39: 1386-7(Sept. 1968).

A transformer was designed to match an electron multiplier to a low impedance coaxial cable in order to overcome electronic noise difficulties arising from using the channel multiplier as an energy analyzer near the ion source of a mass spectrometer. (B.G.D.)

**45373** AUTOMATIC MULTIPARAMETER DATA COLLECTION. Green, P. J. (Louisiana State Univ., Baton Rouge); Williams, R. E.; Tompkins, D. R. Rev. Sci. Instrum., 39: 1289-93(Sept. 1968).

A system which digitally analyzes multiple simultaneous voltage pulses is described in detail. The system uses a pulse height analyzer with paper tape readout. Simultaneous voltage pulses are stored to allow sequential analysis and routing to memory subgroups of the analyzer. Immediate memory readout accomplishes simultaneous pulse correlation with the memory address identifying the parameter number and pulse height. The single address in

each memory subgroup storing a 1 is punched which minimizes the tape readout per event and allows tape storage of several thousand events. The dead time is 2nt where n is the number of memory channels of the analyzer and t is the readout time per character. Although the deadtime (approximately 7 sec for a 200 channel analyzer with a 60 character/sec punch) limits the system's use to low count rates, a suggested improvement is included which reduces the deadtime to 3n't where n' is the number of parameters to be recorded (0.21 sec for 4 parameters with a 60 character/sec tape punch). (auth)

**45374** AUTOMATIC DATA PLOTTING METHOD FOR PULSED EXPERIMENTS. Harries, W. L. (Princeton Univ., N. J.). Rev. Sci. Instrum., 39: 1294-5(Sept. 1968).

A general analog method of automatically plotting the parametric dependencies of quantities measured in pulsed experiments is described, i.e., if a quantity y is measured vs time in a series of shots, each with a different value of a parameter x, then a plot of y vs x for a series of given times is obtained. An oscilloscope and film are used as readout and memory, and a specific circuit with a frequency response up to 120 kc is given. (auth)

**45375** MEASUREMENT OF THE DENSITY OF THE NEUTRAL GAS IN THE OPERATING REGIME OF THE PR-5 INSTALLATION. Kotel'nikov, Yu. N.; Kutukov, G. P. Zh. Tekh. Fiz., 38: 818-22 (May 1968). (In Russian).

The pulse manometer, designed for measurement of the low-pressure neutral gas when the plasma was in a magnetic field, changing with time and direction, was described. The results of the use of the device in experiments on the PR-5 were reported. The regularities discovered were discussed. (tr-auth)

**45376** ELECTROCHEMICAL OXYGEN METER (Engineering Materials). (United Nuclear Corp., Elmsford, N. Y.). (CAPE-1759).

13 drawings.

A liquid metal oxygen meter, an on-line instrument for continuously measuring the effective oxygen content in liquid metals without sampling and chemical analysis, is described. It is specific for oxygen and is useful in the range from 1 to 100 ppM. It is sensitive to small changes in oxygen concentration at low levels. Response to changes in oxygen content is rapid but the meter is relatively insensitive to changes in liquid metal temperature and liquid metal velocity. (For details see TID-4100 Suppl. 47) (See also 22: 28211). (F.S.)

**45377** CONDITIONER WITH INTEGRATED CIRCUITS FOR NEUTRON TIME-OF-FLIGHT EXPERIMENT DATA SELECTION. Colling, F.; Stueber, W. (EURATOM, Geel, Belgium). Nucl. Instrum. Methods, 64: 52-60(1968).

An electronic calculating unit is described, which is able to select from sequentially arriving binary coded nuclear event data only those, which fall into certain prescribed regions of numerical value, and to transform the accepted data in such a way that: the channel width of the preceding analog-to-digital converter can be increased by powers of 2 in each region independent of the others and the data can be stored without useless gaps in a digital sorting memory. Up to 8 regions can be selected with independent locations in the spectrum. Data words of up to 17 bits can be handled, with a maximum total processing time of 6 $\mu$s. The unit is composed mainly of TTL-elements. Facilities for simple faultless programming and for test are provided. The realized conditioner can execute the function of the accordeon for TOF-analyzers not equipped with this feature, with the advantage that data can be processed off-line as well as on-line. Simple extensions will allow: application of the conditioner for multiparameter experiments, e.g., by combining several units; electrical transfer of manually set-up region for future calculations. (auth)

**45378** CORROSIVE LIQUID FLOW METER. Holm, Dale M.; Deverall, John E. (to United States Atomic Energy Commission). U. S. Patent 3,401,260. Sept. 10, 1968.

A liquid flow meter having a remote radioactive detector and a source of radioactivity in the liquid is described. The liquid falls through a chamber while a fast-acting valve prevents the influx of more liquid to the chamber so that the rate of fall of the liquid is proportional to the flow rate. (AEC)

## Radiation Effects on Instruments and Instrument Components

**45379** RADIATION EFFECTS ON DIODES AND TRANSISTORS. Zander, K. Nachrichtentech. Fachber., 32: 111-18(1967). (In German).

A critical review is given of the most important experimental data on the radiation modification of diodes and transistors. The most significant viewpoints with respect to the modification of the electric characteristics of these elements under irradiation are indicated. 19 references. (J.S.R.)

# LIFE SCIENCES

## Biochemistry, Physiology, and Molecular Biology

*Refer also to abstracts 45287, 45300, 45565, 45602, 45644, 45648, 45658, 45662, 45674, 45675, 45682, 45690, 45704, 45711–45713, 45723, 45727, 45733, 45737, and 45740.*

**45380** (EUR-3290f-e) STABILITE CHIMIQUE DES BASES PYRIMIDIQUES TRITIEES ET QUELQUES PROBLEMES POSES PAR LEUR UTILISATION EN BIOLOGIE. (Chemical Stability of Tritiated Pyrimidine Nucleosides and Some Problems Raised by Their Use in Biology). Goutier, R.; Sirchis, J.; Winand, M. (eds.) (European Atomic Energy Community). Aug. 1967. 88p. (In English and French). (CONF-650332-). Dep.

From Proceedings of the Colloquium, Mol, Belgium.

Eight papers are presented on the preparation and use of tritium-labeled pyrimidines. Four separate abstracts are prepared on the distribution of tritium-labeled thymidine in animals, problems on the biological use of tritium-labeled thymidine, lethality from tritium-labeled nucleosides incorporated in mammalian cells, and isotopic discrimination between tritium and carbon-14 in vitro during enzymatic phosphorylation of labeled thymidine. (E.R.B.)

*For abstracts of individual papers see: 45381–45383 and 45506.*

**45381** (EUR-3290f-e, pp 29-38) DISTRIBUTION OF TRITIATED THYMIDINE IN ANIMALS AS SHOWN BY WATER-SOLUBLE AUTORADIOGRAPHY. Pelc, S. R.; Appleton, T. C. (Medical Research Council, London (England). Biophysics Research Unit).

A new technique is described for studying the incorporation of labeled soluble compounds in which the labeled material is immobilized. No materials that might leach out soluble compounds are used until after the completion of radiographic exposure. The technique is both simple and reliable. Frozen sections of the labeled tissue are cut on a Pearse cryostat housed in the darkroom and picked up on cold cover-slips coated with Kodak AR.10 stripping film. The cover slips are stored, exposed, processed, and stained in perspex racks to avoid breakage. The sections are kept frozen until completion of the exposure. (E.R.B.)

**45382** (EUR-3290f-e, pp 73-7) LETHALITY FROM $^{3}$H-NUCLEOSIDES INCORPORATED IN MAMMALIAN CELLS. Marin, G. (International Lab. of Genetics and Biophysics, Naples (Italy)).

Preliminary results are reported for a series of experiments designed to determine the effectiveness of tritium-labeled thymidine incorporation as opposed to tritium-labeled uridine incorporation in causing cell death, and the effects of time of incubation at 20°C on the survival of cells exposed to constant doses of tritium-labeled thymidine or tritium-labeled uridine. It was shown that thymidine-incorporated tritium was more effective than uridine-incorporated tritium in causing the death of cultured hamster fibroblast cells. The explanation of this seems to be that the former is confined to the nucleus of the cell in the form of DNA whereas the latter, after incorporation in the nucleus, moves to the cytoplasm as ribosomal RNA. Results of the second series of studies show that increasing the period of incubation at 20°C reduces the survival of the thymidine-labeled cells to a greater extent than the uridine-labeled cells. These results, under conditions of delayed division, appear to confirm the nuclear damage concept for cell lethality. (E.R.B.)

**45383** (EUR-3290f-e, pp 79-88) ISOTOPIC DISCRIMINATION BETWEEN $^{3}$H AND $^{14}$C IN VITRO DURING ENZYMATIC PHOSPHORYLATION OF LABELLED THYMIDINE. Goutier, R.; Baugnet-Mahieu, L.; Semal, M. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

Experiments were designed to determine the reason for differences in the in vitro enzymatic phosphorylation of labeled thymidine in liver extracts when tritium or carbon-14 was used as the label. Using actively regenerating liver extracts from male Wistar rats and purified thymidine kinases, it was determined that the phosphorylation of tritium-labeled thymidine in the extracts was only 0.6 to 0.8 that of carbon-14-labeled thymidine. It was suggested that the presence of tritium on the thymine moiety interfered with the binding or release of the thymine from the active center of the enzyme. The possibility of this isotopic discrimination occurring in vivo is reduced by the reduction of the substrate/enzyme ratio. (E.R.B.)

**45384** CHANGES IN THE FORMATION OF HEINZ BODIES, THE ACTIVITY OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE AND GLUTATHIONE REDUCTASE, AND THE CONCENTRATION AND STABILITY OF REDUCED GLUTATHIONE IN ERYTHROCYTES IRRADIATED IN VIVO AND IN VITRO. Nenci, G. G.; del Piano, E.; Lisi, B. (Univ., Perugia, Italy). Haematologica, (Pavia), 52: 551-62(1967). (In Italian).

Some effects of radiation on red cells were studied in patients submitted to $^{60}$Co irradiation for various malignant diseases, and in erythrocytes irradiated in vitro with the same source. The formation of Heinz bodies after incubation with acetylphenylhydrazine was investigated in relation to the cell concentration of glutathione, glutathione reductase, and glucose-6-phosphate dehydrogenase (G-6-PDH). While glutathione content and stability remained unchanged, and the activities of the enzymes were only slightly modified, Heinz body formation was significantly depressed in erythrocytes irradiated in vivo and in the range 500 to 3000 rad in vitro. The number of Heinz bodies in red cells of irradiated patients fell from an average of 2310 per 1000 cells before irradiation to 2002 after cumulative doses of 1500 to 2250 rad and to 1666 after 3000 to 4500 rad. At the same time reduced glutathione content fell from 72.1 mg% initially to 71.6 and then to 68.0 after the higher dose. Contrary to the effect of in vivo irradiation, the number of Heinz bodies increased markedly after in vitro irradiation of erythrocytes. (BBB)

**45385** METABOLISM OF $^{65}$Zn IN CIRRHOSIS. Kahn, Arthur M.; Rizer, James G.; Thomas, Ponchita B.; Gordon, H. Earl (Veterans Administration Center, Los Angeles, Calif.). Surgery, 63: 678-82(Apr. 1968).

The uptake of parenterally administered $^{65}$Zn was measured in the liver, spleen, and serum of cirrhotic rats that received subcutaneous injections of 0.1 $\mu$Ci/100 g. Carbon tetrachloride-induced cirrhosis significantly decreased the levels of liver and serum $^{65}$Zn. The uptake of $^{65}$Zn in cirrhotic livers was significantly greater than in normal livers. On the other hand, the serum and spleen of the cirrhotic animals took up significantly less of the $^{65}$Zn than those of the control group. The gastrointestinal absorption of $^{65}$Zn was determined in normal and cirrhotic rats following intragastric administration. The control group absorbed an average of 30.7% of the administered dose, compared to 38.5% for the cirrhotic group (not a statistically significant difference). Urine excretion of $^{65}$Zn was measured daily in cirrhotic and normal rats; no differences in the excretion were detected. Increased uptake of parenterally administered $^{65}$Zn by the cirrhotic liver and by normal gastrointestinal absorption and urinary excretion suggest that the Zn deficiency in the serum and liver of cirrhotic rats may be due to dietary deficiency. (BBB)

**45386** ADAPTATION OF THE THYROID GLAND TO IODINE DEFICIENCY. Hagmueller, K. (Paracelsus-Institut, Bad Hall, Austria). Z. Biol., 116: 28-60(Feb. 1968). (In German).

Thyroid weight and various parameters of radioiodine turnover were investigated in different groups of rats: In 262 control rats, 96 rats on I-deficient yeast diet (Y rats) in which some were put on deficiency at birth and others at 3 weeks after birth, and 57 descendants of I-deficient rats that were also maintained in iodine deficiency and consisted of 3 successive generations (F rats). Maximum I deficiency lasted for 420 days. In Y rats, shortly after initiation of I deficiency, the 24-hr $^{131}$I uptake of thyroid tissue and the serum PB $^{131}$I showed a temporary increase. As these parameters fell to normal the thyroid weight doubled, the 24-hr urinary excretion of $^{131}$I fell to 50% of the normal value and remained low. The PB$^{127}$I decreased moderately. In contrast, F rats showed a 24-hr $^{131}$I uptake in the normal range, increasing with continuance of I deficiency. The serum PB$^{131}$I was elevated throughout the experiment. Thyroid weight, which initially was elevated, gradually diminished. Single high doses of iodide (7.2 mg/100 g body weight) produced small elevations of PB$^{127}$I in the serum of control animals and of Y animals, but did not alter the diminished renal iodine excretion of Y rats during the first 24 hr. (BBB)

**45387** TRANSPORT OF CESIUM IN FROG MUSCLE. Beauge, L. A. (Univ. Nacional de Cordoba, Argentina); Sjodin, R. A. J. Physiol. (London), 194: 105-23(Jan. 1968).

The entry of $^{134}$Cs into frog sartorius muscle cells was strongly suppressed by the presence of $10^{-3}$M strophanthidin in Ringer solution. The amount by which Cs entry was reduced in the presence of strophanthidin was dependent on the intracellular Na concentration and was greater the higher the intracellular Na concentration. The magnitude of Cs influx in the absence of strophanthidin was highly dependent on the intracellular Na concentration. Cesium

uptake by muscles in which Na was largely replaced by Li was reduced to very low values. Cesium could promote the extrusion of Na from muscles with high intracellular Na concentrations. The effects of 24 mM Cs and 5 mM K on Na extrusion were roughly the same. External K inhibited the entry of Cs ions into muscle cells presumably by competing for transport sites. The drug strophanthidin had no effect on $^{134}Cs$ efflux provided that muscles were loaded with tracer ions for a long period of time. Cesium efflux from the intracellular compartment appeared to occur by a process not mediated by metabolism. The action of strophanthidin on $^{134}Cs$ efflux from muscles exposed to tracer for short times suggested that Cs ions were transported inwardly by an active process after first accumulating in a superficial reservoir. (BBB)

**45388** EFFECT OF TOTAL-BODY X IRRADIATION ON THE PROPERTIES OF POLYRIBOSOMES IN NORMAL AND REGENERATING RAT LIVER. **Baeyens, W.; Goutier, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Arch. Int. Physiol. Biochim., 75: 875-7(1967).**

Polysomes were prepared from normal and regenerating rat liver after total-body x irradiation with doses ranging from 1000 to 6000 R. Other rats undergoing partial hepatectomy after irradiation received only 1000 R. The total yield of polysomes per liver was about 50% lower in the irradiated animals, whether hepatectomized or not. Sucrose density gradient analysis of polysomes prepared from normal rats 24 hr after irradiation, revealed an increased proportion of rapidly sedimenting polysomes with aggregate size $n > 5$ for all doses up to 6000 R. Polysomes prepared from 24-hr regenerating liver taken from rats irradiated by 1000 R immediately before hepatectomy also showed a consistent increase in heavy polymers. When compared in an in vitro amino-acid-incorporating system, the polysomes derived from irradiated animals showed an increased synthetic activity, in agreement with their higher content of large polymers. Incubation of polysomes from irradiated animals with poly U resulted in a smaller stimulation of phenylalanine uptake as compared to non-irradiated controls, in agreement with the observed decrease in monosomes in preparation from irradiated rats. Inhibition of the synthesis of the heavier fraction of nuclear RNA was shown in irradiated regenerating rat liver. A possible interpretation of the observed phenomena could have been that after irradiation a decreased production of messenger-RNA (m-RNA) molecules allowed the binding of a greater number of ribosomes to each m-RNA molecule. However, experiments with actinomycin D did not confirm this hypothesis: intraperitoneal injection of actinomycin D result in a decreased proportion of the larger polysomes. There were some indications that factors other than m-RNA synthesis might be involved. Electron microscopic examination of polysomes showed the presence of membrane-like structures in the irradiated preparations, whereas the nonirradiated samples showed only ribosomal aggregates, devoid of membranous structures. (BBB)

**45389** HYPOTHALAMIC INFLUENCES ON THE MOTOR ACTIVITY OF THE SMALL INTESTINE IN ACUTE RADIATION SICKNESS IN THE DOG. **Pochechueva, G. S. (Inst. of Experimental Medicine, Moscow. Central Roentgen-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med., 65: No. 2, 30-3(Feb. 1968). (In Russian).**

The influence of hypothalamus on the motor activity of the small intestine under conditions of penetrating radiation in chronic experiments on four dogs with implanted stereotaxically electrodes and intestinal fistulae was studied. The more severe the radiation sickness the more markedly was the influence of hypothalamus on the motor activity of the small intestine affected. It was likewise shown that the functional state of the hypothalamic area is itself affected by x irradiation. (auth)

**45390** STUDY OF EFFERENT IMPULSATION IN POSTGANGLIONIC FIBERS AFTER THE ACTION OF IONIZING RADIATION. **Maiorova, N. F. (Inst. of Experimental Medicine, Moscow. Central Scientific Research Roentgeno-Radiological Inst., Moscow). Byull. Eksp. Biol. Med., 65: No. 2, 24-7(Feb. 1968). (In Russian).**

Changes in bioelectric activity of postganglionic fibers to the intestine, spleen, kidney, and bladder were observed 5 to 10 min after administration of 550 R of whole-body x radiation to cats. Although the activity was diminished in some nerve fibers, it was intensified in most of the fibers. A wave-like variation in activity occurred during a period of 3 to 4 hrs of observations following irradiation. The mosaic-like character of the responses to ionizing radiation is evidence of the functional heterogeneity in the nervous system. (H.L.W.)

**45391** IODINE-LABELLING IN THE STUDY OF THE BIOCHEMISTRY OF INSULIN. **Brunfeldt, K. (Steno Memorial Hospital, Gentofte, Denmark). Acta Med. Scand., Suppl., 476: 53-74(1967).**

Extensive data on the radioiodination of insulin and its effect on biological activity are reviewed. Relative usefulness of $^{131}I$ and $^{125}I$ is compared. At present $^{125}I$ is generally employed in labeling. Location of radioiodine in the molecule was discussed. (BBB) (TSS)

**45392** DELAYED STRONTIUM ABSORPTION IN POSTMENOPAUSAL OSTEOPOROSIS AND OSTEOMALACIA. **Gutteridge, D. H.; Robinson, C. J.; Joplin, G. F. (Royal Postgraduate Medical School, London). Clin. Sci., 34: 351-63(Apr. 1968).**

Following a combined oral dose of $^{47}Ca$ and stable Sr, serum levels (% dose/l) were followed for up to 12 hr. Nineteen such combined studies were completed on normal subjects, 27 in osteoporosis, 10 in steatorrhea, and 12 in patients with miscellaneous disorders. A Strontium Absorption Delay Index (the 6-hr minus the 2-hr value of $Sr/^{47}Ca$) was derived; it is an expression of the time course of the Sr absorption as related to the $^{47}Ca$ absorption. The simpler value of $Sr_{6\,hr} - Sr_{2\,hr}$ gave similar information. A raised (>0.1) Index characterized the following conditions: postmenopausal and idiopathic male osteoporosis (all of 15 tests), osteomalacia due to steatorrhea (all five tests), and idiopathic hypercalciuria with or without urolithiasis (three of four tests). Some (three of five) tests in elderly women without radiological vertebral fractures gave similar high values. Normal values for the Index (nine of 12 tests) were found in inactive osteoporosis, tested after cessation of the precipitating factor (pregnancy, immobilization, steroid therapy) or after its correction (androgen deficiency). It was inferred that a raised Index showed active bone disease requiring treatment and could be of practical value in evaluating the need for therapy and its effectiveness. Delayed Sr absorption could indicate a tendency of the upper gut to maintain the absorption of Ca at the expense of Sr in association with certain forms of bone disease. (BBB)

**45393** DETERMINATION OF THE DISTRIBUTION OF $^{32}P$ AND $^{51}Cr$ MICROSPHERES BY EXTERNAL BREMSSTRAHLUNG MEASUREMENT. **Fava, Giannino; Roncoroni, Luigi; Soai, Saudo (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 51: 189-98(May-June 1965). (In Italian).**

Theoretical and practical aspects of following $^{32}P$ used intra-arterially in radiotherapy are reported. Treatment with microspheres of $^{32}P$ and $^{51}Cr$-labeled cationic resin in colloidal solution resulted in their distribution in the capillary arterial network of tumors and surrounding tissues. To study the density of distribution provided by the microspheres in the patient's body, the use of an adequately collimated scintillating counter, utilizing the intense Bremsstrahlung of $^{32}P$ (therapeutic dose) and the $\gamma$ radiation of $^{51}Cr$ (tracer dose), is proposed. Different techniques, depending on the extension of the radioactivity (as well as of the diffusing medium surrounding it), were used. The isodose plot was obtained. The introduction of radioactive microspheres, according to the described technique, allows rapid localization as well as a high concentration of a radionuclide in organs or in parts of organs containing malignant tumors. (BBB)

**45394** A STUDY OF RADIATION DAMAGE IN NEUROHORMONAL TRANSMITTERS USING ELECTRON SPIN RESONANCE TECHNIQUES. Tipton, Douglas Franklin, Nashville, Vanderbilt Univ., 1967. 80p.

Thesis.

Research contained in this thesis was carried out to investigate free radicals that are created by radiation damage in neurohormonal transmitting substances using the Electron Spin Resonance technique. Substances involved in both adrenergic and cholinergic neurohormonal transmission were investigated in polycrystalline form. Acetylcholine (ACh), choline (Ch), and tetramethylammonium (TMA) halides, as well as cholinesterase (ChE), were studied in connection with the cholinergic substances. Serine, tyrosine, histidine, and tryptophan were studied along with ChE. The adrenergic substances were adrenalin and noradrenalin in addition to similar compounds such as $\beta$-hydroxphenylethylamine ($\beta$-HPEA), 2-phenylethylamine (PEA), and catechol. Ultraviolet light, 50 KVP x rays, and $^{60}Co$ $\gamma$ rays were used as the source of radiation. The temperatures of irradiation and analysis were 77°K and room temperature (300°K). Samples of the cholinergic materials were tested in air, vacuum, and nitrogen environments. In addition to these environments, adrenergic substances were tested in oxygen. ChE, adrenalin, and noradrenalin were also tested in water solution form. Results obtained from the adrenergic substances indicated that the damage at both 77°K and 300°K, in all environmental conditions, was located on the benzene ring. A singlet with a linewidth of 8 gauss and $g = 2.0045$ was observed for adrenalin. Noradrenalin and catechol produced a doublet with a hyperfine splitting of 8 gauss and $g = 2.0045$. $\beta$-HPEA and PEA produced a triplet splitting was 50 gauss, and the quartet splitting was 10 gauss. The g-value was very close to 2.0023. Data from ChE were markedly similar to

that of serine at 77°K, while different radical species were observed in each compound after warmup to 300°K which were not similar. At 77°K the spectrum of ChE consisted of a doublet with hyperfine splitting of 21 gauss, which was identical to the serine spectrum, and a singlet absorption which was not identified although it could have been attributed to either tyrosine, tryptophan, or histidine. Oxygen in the environment of ChE did not affect the radical species at 77°K, but the spectrum at 300°K decreased rapidly in the presence of oxygen. The spectrum of ChE in solution form was identical to that of powdered ChE. (Disser. Abstr.)

**45395** FINE STRUCTURE OF THE RADIATION REACTION IN ADRENAL CORTICAL CELLS AFTER A SINGLE DOSE OF X RAYS. **Klug, H. (Univ., Charite, Berlin). Beitr. Pathol. Anat. Allg. Pathol., 136: 229-44(1967). (In German).**

The zona fasciculata of the adrenal cortex of rats was examined by the electron microscope one, three, 12, and 24 days after a single x-irradiation dose of 400 R. One day after irradiation alterations had already appeared in the outer membrane of mitochondria of the clear cells whereas the matrix was consolidated. The vesicular structures of the endoplasmic reticulum had largely disappeared. With increasing intervals after irradiation, vacuolar formations developed in the lipid inclusions where the whole cytoplasm showed loss of fine structure. Between the mitochondria small vesicles in large numbers appeared, which were possibly fragmented mitochondria membranes. The changes in the outer membrane of mitochondria and the lipid inclusions also appeared in the dark cells but further alterations of cytoplasm could not be observed due to the high electron density of these cells. At all times after irradiation no essential changes in the nuclei could be detected. (BBB)

**45396** RESEARCH IN PROGRESS. THE FORMATION OF NICOTINAMIDE-ADENINE-DINUCLEOTIDE FROM TRYPTOPHAN AFTER WHOLE-BODY IRRADIATION. **Streffer, Chr. (Univ., Freiburg i. B.). Ger. Med. Mon., 12: 35-6(Jan. 1967). (In English and German).**

The synthesis of the coenzyme nicotinamide adenine dinucleotide (NAD) was studied in female mice from an outbred strain x irradiated with 810 R. Both the NAD level in the liver and the incorporation of $^{14}C$-labeled tryptophan into the NAD molecule had fallen significantly seven days after irradiation. This occurred with tracer as well as with large doses of tryptophan. There was no difference between the livers of irradiated and nonirradiated in the incorporation of nicotinic acid into NAD. Kynureninase activity was significantly reduced. (BBB)

**45397** THE ATTACK OF FREE RADICALS ON BIOLOGICALLY ACTIVE DNA IN IRRADIATED AQUEOUS SOLUTIONS. Blok, Joh; Verhey, W. S. D. (National Defence Research Organization TNO, Rijswijk, Netherlands). Radiat. Res., 34: 689-703 (1968).

DNA isolated from the bacteriophage $\phi$X174 was irradiated with $\gamma$ rays in a solution of pH 7.0 buffered with 0.01 M phosphate. At concentrations of a few milligrams per milliliter the yield of inactivation was 1.9 molecules of DNA per 100 eV of absorbed energy. The radiosensitivity in oxygen and nitrogen did not differ significantly. Bubbling with nitrous oxide increased the yield by a factor of two. These yields were derived from measurements of the 37% survival dose as a function of DNA concentration. Potassium iodide was strongly protective. Because potassium iodide scavenged OH radicals whereas nitrous oxide converted hydrated electrons into OH radicals, it was concluded that in concentrated DNA solutions at least 95% of the inactivations may be attributed to primary attack by OH radicals, although reducing radicals were not completely inactive. At concentrations of a few micrograms per milliliter the yield of inactivation was lower by an order of magnitude and reducing radicals were relatively more important. From the protection afforded by free nucleotides it was concluded that OH radicals reacted about five times as fast with free nucleotides as with nucleotides in single-stranded DNA. In the presence of free pyrimidine nucleotides oxygen enhanced the radiosensitivity considerably. (auth)

**45398** $^{32}P$ UPTAKE IN LICHEN SCLEROSUS ET ATROPHICUS OF THE VULVA. **Kaufman, Raymond H.; Gardner, Herman L.; Johnson, Philip C. (Texas Medical Center, Houston). Amer. J. Obstet. Gynecol., 98: 312-19(June 1, 1967).**

Use of a radioisotope method to demonstrate the lesions of lichen sclerosus et atrophicus (LSA) was investigated. Each of seven patients and five control subjects was injected intravenously with 500 $\mu$Ci of $^{32}P$ at the start of the study. Three hr later, multiple sites over the vulva were scanned for radioactivity. Counts were obtained over the lesions involving the vulva and over normal skin in comparable areas, or adjacent to the lesions, in the same patients. The uptake of $^{32}P$ by the skin in areas of LSA was not significantly greater than the uptake by normal skin from comparable sites on the vulva. The uptake of radiophosphorus by the vulvar skin decreased the further away from the midline that the counts were obtained. It is suggested that this may account for some of the differences in uptake of $^{32}P$ by diseased and normal vulvar skin that were reported in the literature. When counts were taken lateral to the lesion, on the lateral aspect of the vulva, and were compared with the counts obtained over the lesion on the medial aspect of the vulva, an erroneous impression was obtained that the uptake of radiophosphorus by the diseased skin was greater than that of normal skin. (BBB)

**45399** $^{85}Sr$ AND $^{45}Ca$ UPTAKE BY RAT FROM BROWN SEAWEEDS. Enomoto, Yoshikazu; Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 26-8(Mar. 1968).

The brown seaweeds have a preference for $^{85}Sr$ and metabolically absorb this nuclide two to three times as much as $^{45}Ca$ from seawater. Three kinds of brown seaweeds that previously incorporated $^{85}Sr$ and $^{45}Ca$ were administered to rats by a stomach tube. The amount of $^{85}Sr$ that was retained in these rats was much less than that in a control group; there was no significant difference for $^{45}Ca$ retention. These facts were attributed to alginate contained in the brown seaweeds. (auth)

**45400** RETENTION OF RADIOACTIVE IRON BY THE MOUSE AFTER INGESTION OF LABELED WHEAT AND BARLEY. **Narula, K. K.; Wadsworth, G. R. (London School of Hygiene and Tropical Medicine). Proc. Nutr. Soc., 27: 9A-10A(Mar. 1968).**

The retention of $^{59}Fe$ by mice fed $^{59}Fe$-labeled barley (14.1% of that fed; range, 12.0 to 18.3%) was greater than that from $^{59}Fe$-labeled wheat (12.9%; range, 8.5 to 14.5%). Retention was expressed as the percentage of the radioactivity ingested that remained in the bodies of the mice after an interval of 10 days. Radiation was measured in a whole-body counter. The retention of $^{59}Fe$ by the mice was about three times as much as that retained by human subjects investigated earlier using labeled wheat. The present results were about the same as those found for absorption of radioactive Fe from beans by rats. Thus the mouse and rat could not be used as test animals to provide an exact measure of availability to humans of Fe in foods, but this did not preclude their use to differentiate between comparative availability of Fe from different foods and diets. (BBB)

**45401** ACCUMULATION OF $^{137}Cs$ BY FRESH WATER PLANTS UNDER EXPERIMENTAL CONDITIONS AND IN NATURAL WATER BASINS. Kulikov, N. V.; Lyubimova, S. A.; Fleishman, D. G. (Inst. of Plant and Animal Ecology, Moscow. Inst. of Evolution Physiology and Biochemistry, Moscow). Dokl. Akad. Nauk SSSR, 178: 1407-9(Feb. 21, 1968). (In Russian).

Comparisons were made of the uptake of $^{137}Ce$ by various freshwater plants under natural and simulated conditions. Fresh water plants from the Large Miass and Large Taktul lakes in the South Urals were collected for the studies. The recording efficiency for $\gamma$-quanta recording of $^{137}Ce$ in the band energy from 610 to 710 keV was 20% with the background of 24 pulse/min. Tabulated data of the cesium-137 uptake by 25 types of fresh-water plants showed that some species exhibited a much more active uptake of the cesium-137 than others; this was best observed in the cesium content of the ash residue. The highest uptake among the algae was observed in the Spirogyra sp. and Chara fragilis. The moss, Drepanocladus sendtneri, exhibited a very high level of uptake, and among the higher species, the highest uptake was observed in duck weed (Lemna minor L.). Average content in ash changed in the following order: moss > floating plants > algae > off shore water plants > submerged plants; for the dry mass: moss > algae > floating plants > offshore water = submerged plants. (R.V.J.)

**45402** INCREASED EXCRETION OF $^{137}Cs$ IN HUMANS BY PRUSSIAN BLUE. Madshus, Kjell; Stroemme, Aksel (Norsk Hydros Inst. for Cancer Research, Oslo). Z. Naturforsch., 23b: 391-2(Mar. 1968).

Cesium-137 was administered orally to six men, and several months later Prussian Blue was administered. In doses of 3 g per day Prussian Blue had no observable prophylactic effect. One gram was taken three times in one day by two subjects and the same dose the next day together with $^{137}Cs$. The $^{137}Cs$ body burden rose by the same order as previously when the same amount of $^{137}Cs$ had been administered, but without Prussian Blue. The increase of the excretion of $^{137}Cs$ after doses of 0.5 g of Prussian Blue 3 times a day was small. In five cases one gram of Prussian Blue was given three times a day for several days. In these cases the $^{137}Cs$ biological half life was reduced from 94 to 31 days. A graph shows the average $^{137}Cs$ biological half life before and after the administration of Prussian Blue calculated by the method of least squares. The biological half life of $^{137}Cs$ is between 70 and 127 days before the administration of Prussian Blue and between 27 and 41 days after. (H.L.W.)

**45403** THE LOCALIZATION OF $^{65}Zn$ IN GERMINATING CORN TISSUES. Diez-Altares, Carmen (Univ. de Carabobo, Valencia, Venezuela); Bornemisza, Elemer. Plant Soil, 57: 175-88(Feb. 1967).

Zinc-65 was added to germinating corn seeds (50 $\mu$Ci/100 seeds) and several days later the plants were separated into roots, grains, and leaves. The distribution of $^{65}Zn$ in the different solubility groups of proteins and cell wall constituents was studied. Most of the $^{65}Zn$ was recovered in the soluble protein fraction, the highest values corresponding to the solubility groups for basic proteins, albumins, and globulins. The prolamines and glutelins also contained an appreciable proportion of $^{65}Zn$. Nondialysable percentages of $^{65}Zn$ varied considerably, between 0.1 and 19.9% of that absorbed. The lowest figures were in the saline extracts and especially in the grain fraction. In the cell wall constituents, most $^{65}Zn$ was present in the solubility groups corresponding to protopectins and hemicelluloses. After various extraction procedures, a tightly bound $^{65}Zn$ fraction remained attached to the cell wall. This could only be separated by boiling with KOH leaving Zn-free cell wall material. The pure $\alpha$-cellulose walls contained no $^{65}Zn$. (BBB)

**45404** EFFICIENCY OF FEMALE SEX HORMONES AND P-POOR AND Ca-RICH DIETS IN $^{90}Sr$ DECORPORATION. Steinbach, Irmhild (Heiligenberg Institut, Ger.). Z. Naturforsch., 23b: 820-4(June 1968). (In German).

In two separate series of studies with male rats and castrated male rats, the effect of P-poor and Ca-rich diet, estrogen, and progesterone on $^{90}Sr$ metabolism was investigated. Phosphorus-poor and Ca-rich diets depressed the $^{90}Sr$ content. Estrogen led to an increased $^{90}Sr$ retention. With progesterone no effect on the $^{90}Sr$ elimination could be detected. In combined treatment, the three types of treatment had an additive effect. (tr-auth)

**45405** SECRETION RATE OF DIETARY IODINE INTO HUMAN MILK. Chiba, Morito (Japan Analytical Chemistry Research Inst., Tokyo); Ichikawa, Ryushi. J. Radiat. Res., 9: 12-18(Mar. 1968).

In view of possible radioactive iodine accumulation by thyroid of breast-fed infant through maternal milk under a certain contaminated environment, the secretion rate of dietary iodine into human milk was estimated by iodine determination for diet and milk. For several hundred $\mu$g daily intake level, the secretion rate was around 10 per cent; less than 1 percent was found for 10 mg intake level. (auth)

**45406** MINIATURE SWINE: DEVELOPMENT, MANAGEMENT, AND UTILIZATION. Bustad, L. K. (Univ. of California, Davis); McClellan, R. O. Lab. Anim. Care, 18: 280-7(Apr. 1968).

Use of miniature swine in radiobiologic and other studies was surveyed. A long-term study of the effects of daily ingestion of $^{90}Sr$, using over 1000 miniature swine with 300 animals maintained for lifetime observation, has been in progress at Richland, Washington, since 1958. The miniature pig was selected because it was a long-lived omnivore similar in size to man. These features were particularly desirable in defining the potential hazard of $^{90}Sr$ to man. A high incidence of hematopoietic tissue neoplasms was observed in these miniature swine ingesting high levels of $^{90}Sr$ for two to three yr. Swine were also used to study the gastrointestinal absorption of the radioisotopes produced and used in nuclear industry. Such studies have shown that radioisotopes such as $^{137}Cs$, $^{147}Pm$, and Pu, which may be used in terrestrial or space radioisotope power sources, were only slightly absorbed from the gastrointestinal tract. The pig was also used to study the effectiveness of chelating agents, such as diethylenetriaminepentaacetic acid, in removing Pu deposited within the body. (BBB)

**45407** C-REACTIVE PROTEIN DURING RADIOTHERAPY OF MALIGNANT TUMORS. Holsti, Lars R. (Univ., Helsinki). Ann. Med. Inter. Fenn., 56: 127-30(1967).

C-reactive protein (CRP) was followed during radiotherapy of 68 patients with cancer, but no statistically significant rise or fall was observed. Radiation therapy was given as 33-MeV photons or 20 to 34-MeV electrons or $\gamma$ rays from a 3000-Ci $^{60}Co$ unit. The daily tumor dose was 170 to 200 rad and the total tumor dose 5000 to 6000 rad in 5 to 8 weeks. Treatment was administered six times per week. CRP was determined prior to the initiation of radiotherapy, three hr after the first irradiation, after three and six irradiations, mid-way through the course and at the end of the treatment. No significant increase or decrease occurred. An increase in CRP was seen at the end of treatment in 14 out of 47 cases. It seemed that CRP increased as a result of tissue irradiation irrespective of whether the irradiated tissue was malignant or normal. During the interval in split-course therapy, a lessening trend in the reaction was observed but the change was not significant. CRP, because of its nonspecificity, could be used to evaluate tumor response to radiation. (BBB)

**45408** RADICAL TRANSFER IN IRRADIATED NUCLEOHISTONE. Yoshii, Giichi; Saito, Masahiro (Kyoto Univ.). J. Radiat. Res., 9: 1-4(Mar. 1968).

When nucleohistone was irradiated in an aqueous solution, the radicals produced in DNA seemed to be transferred to histone in the absence of Ca ion. It was suggested that by this mechanism, DNA may be protected by histone associating with the former. The transfer of radicals from DNA to histone was prevented in the presence of Ca ion. (auth)

**45409** ELECTRON SPIN RESONANCE STUDIES ON THE DAMAGE OF RIBONUCLEASE EXPOSED TO ULTRA-VIOLET LIGHT. Ichimura, Sachiko (National Inst. of Radiological Sciences, Chiba, Japan); Sawada, Fumio; Someno, Kazuo. J. Radiat. Res., 9: 35-9(Mar. 1968).

Primary damage in RNAase caused by exposure to uv radiation was studied by ESR. Frozen aqueous solutions of RNAase were irradiated by 254 m$\mu$ light; ESR spectra and the remaining enzymatic activity were measured. ESR spectra showed that the free radicals formed in RNAase were localized in chromophores of RNAase; namely tyrosine, phenylalanine and cystine. Effect of warming on the spectra supported these assignments. The amount of radicals in RNAase had a linear relationship with the extent of enzyme inactivation. (auth)

**45410** APPEARANCE OF LOW MOLECULAR WEIGHT DNA IN A REC$^-$ MUTANT OF ESCHERICHIA COLI K 12 IRRADIATED WITH X-RAYS. Morimyo, Mitsuoki (National Inst. of Radiological Sciences, Chiba, Japan); Horii, Zen-ichiro; Suzuki, Kenshi. J. Radiat. Res., 9: 19-25(Mar. 1968).

A Rec$^-$ mutant of Escherichia coli K 12 (JC 1569b) was x irradiated, lysed gently with lysozyme, and centrifuged in alkaline sucrose gradients. The sedimentation profile for DNA demonstrated that x rays produce low molecular weight DNA and that the sedimentation profile altered by irradiation could not be restored after incubation. In contrast, the altered profile for the original Rec$^+$ bacteria was restored almost completely under the same conditions. These results suggested that x irradiation yields single-strand breaks in the DNA of Rec$^-$ and of Rec$^+$ bacteria and that the break in the DNA of Rec$^+$ bacteria could be repaired but not the break in Rec$^-$ bacteria. (auth)

**45411** EARLY CHANGES IN THE EPITHELIUM OF RAT CORNEA AFTER IRRADIATION. Machemer, R.; Suechting, P.; Schuster, R.; Wolfers, W. (Univ., Goettingen, Ger.). Arch. Klin. Exp. Ophthalmol., 170: 311-22(Sept. 7, 1966). (In German).

To study the effect of local irradiation on corneal metabolism, a $^{90}Sr$ applicator was used to irradiate the corneal epithelium of 60 male Wistar rats. Changes in the level of DNA synthesis (as revealed by radioautography with $^3H$-thymidine) and mitotic activity were investigated $\frac{1}{2}$, 2, 6, 12, and 18 hr after $\beta$-ray treatment with 600, 2400, and 6000 rep. At six hr after irradiation there was no change but at 12 hr a depression of about 50% was found in the labeling index. This change seemed to result from impairment of the synthesis of enzymes necessary for DNA synthesis. The mitotic index was depressed immediately and its normalization showed a close relation to the dose applied. Damage to the spindle mechanism required for cell division is discussed as a possible explanation of the observed results. (BBB)

**45412** INVESTIGATION ON RADIATION EFFECTS ON DNA SYNTHESIS IN SYNCHRONOUS CHLORELLA CELLS. Altmann, H.; Fetter, F.; Pfisterer, E.; Szilvinyi, A. v.; Kaindl, K. (Reaktorzentrum, Seibersdorf, Austria). Monatsh, Chem., 99: 1145-52(May-June 1968). (In German).

The variation in the radioresistance of Chlorella cells during their life cycle was compared with regard to DNA synthesis. The most sensitive stage was immediately before the beginning of DNA synthesis and a rapid rise in resistance developed during the S phase. The most resistant stage occurred when DNA synthesis was completed. After irradiation with 10 krads a stimulation of DNA synthesis was observed. After a dose, sufficient to reduce colony-forming ability by 50%, there was only a small reduction in DNA synthesis. At 40 krad ($LD_{90}$) DNA synthesis was strongly inhibited. Possible mechanisms for the variation in radiation sensitivity during the life cycle are discussed. (tr-auth)

**45413** EFFECT OF X-RAYS ON THE ELECTRICAL CONDUCTANCE OF PHOSPHOLIPID BILAYER MEMBRANES. Sutton, A. M.; Rosen, D. (Chelsea Coll. Science Tech., London). Nature (London), 219: 153-4(July 13, 1968).

Damage to cell membranes, affecting their permeability to simple electrolytes, could have appreciable biological consequences. A study is described of this possibility using a system recently introduced as a partial model of the cell membrane; the model membranes comprise optically black structures formed from phospholipid dissolved in hydrocarbons, and have readily measurable

electrical characteristics. The system employed was pure lecithin/n-heptane in various electrolyte solutions. The electrical conductivity was measured before, during, and after x-irradiation at 220 kVp and dose rate up to 600 R/min. Relative changes of conductivity as a function of dose rate on x-irradiation are shown graphically. In all cases the conductivity returned to its initial value when the x-rays were switched off. In order to investigate the nature of the charge transfer process manifested as membrane conductivity, membranes were irradiated in several different electrolyte solutions. Results indicated that the increased conductivity on irradiation derives from ionic rather than electronic movement, and that irradiation causes formation of temporary holes or channels large enough to permit free diffusion of ions. (UK)

**45414** EFFECTS OF WHOLE-BODY X IRRADIATION ON THE ACTIVITY OF VARIOUS ENZYMES AND ON THE PROTEIN LEVEL IN BONE MARROW OF THE RAT. **Richert, J.; Stahl, A. J. C.; Metais, P. (Faculte de Pharmacie, Strasbourg). Bull. Soc. Chim. Biol., 50: 179-85(Mar. 1968). (In French).**

Rats were subjected to single, whole-body x-ray doses up to 1000 R, and assays were made of lactic dehydrogenase (LDH), glucose-6-phosphate dehydrogenase (G-6-PDH), and citrate synthase activity in bone marrow. It was found that decrements of enzyme activity occurred following relatively low doses (150 R). Above 600 R the activity of these enzymes remained stationary, and the total protein content remained practically constant. The variation of the activity of these enzymes and the protein content in the bone marrow was studied as a function of time after irradiation at relatively high doses (800 R). A drop occurred in the activity of the enzymes until the third or the sixth day, depending on the nature of the enzyme. The enzyme activity then rose again. The total protein content rose slowly during the first five days after irradiation, then decreased below the initial value and increased slowly after the eighth day. (BBB)

**45415** PRODUCTION OF ATOMIC HYDROGEN IN GAMMA-IRRADIATED BACTERIOPHAGE AND ITS DNA. **Mueller, A.; Dertinger, H. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 23b: 83-9(Jan. 1968). (In German).**

ESR-spectra of purified preparations of bacteriophage and of extracted DNA were found to contain the characteristic lines of atomic hydrogen after $\gamma$ irradiation at 77°K. The experimental results demonstrate the production of atomic hydrogen by irradiation of organic materials in a direct way. The high stability of the trapped hydrogen atoms is indicated by the fact that heating to 200°K for 10 min reduces the spectral amplitudes by a factor of only two. The yield of trapped atomic hydrogen varied between 0.05 and 0.6, while the total radical yield derived from the ESR-spectra was found between 1.0 and 3.0. Addition of moisture to vacuum-dried samples did not enhance the yield of H atoms. At 50% water content the yield was also reduced to about 50%, other parameters remaining unchanged. The disappearance of hydrogen lines on heating is accompanied by an enhancement of the octet spectrum attributable to the addition of atomic hydrogen to thymine groups. The observation of H stabilization in inorganic phosphates is taken to suggest trapping by phosphate groups in DNA. The efficiency of trapping is probably influenced by the presence of impurities, notably transition metals. The apparent g-factor of 2.014 ± 0.002 is explained by IS-coupling. The true g-factor obtained by application of the Breit-Rabi formula is equal to the free electron value within experimental limits of error. (auth)

**45416** CONTENT OF SOME ORGANIC ACIDS IN ONTOGENESIS OF COTTON AS INFLUENCED BY GAMMA RADIATION. **Arslanova, S. V. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh., No. 6, 7-9(1967). (In Russian).**

The content of citric, malic and oxalic acids in cotton leaves decreased following irradiation; pyroracemic acids increased. The accumulation of the pyroracemic acid appeared to occur due to the dimunition of its use in oxidative metabolism. (auth)

**45417** RADIATION CHEMICAL CHARACTERISTICS OF CERTAIN PEPTIDES. **Sultanov, A.; Tuichiev, A. V.; Ibragimov, A. P. (Inst. of Zoology and Parasitology, Tashkent). Uzb. Biol. Zh., No. 6, 3-6(1967). (In Russian).**

Data on $^{60}$Co $\gamma$ radiation effects on certain peptides in the solid state are reported. The formation of free radicals was studied. The radioinduced output of carbonyl compounds, ammonia, and peroxide was estimated. (auth)

**45418** THE IMPORTANCE OF THE IMMUNOSUPPRESSIVE EFFECT OF THE X RADIATION AND OF THE R-49 AND R-74 LABELLED CYTOSTATIC SUBSTANCES IN RELATION TO THE THERAPY OF THE TUMORS. **Petranyi, Gyozo Magy. Radiol., 20: 234-41(June 1968). (In Hungarian).**

The experimental methods are described that permit the examination of the effect of x ray radiation and the cytostatic substances used in the therapy of tumors on the immune system. The effect of the x radiation and the R-49 and R-74 labeled substances on the survival of skin grafts and the production of antibodies was analysed. Finally, the importance of immunosuppressive effect in respect to the antitumoral reactions is pointed out. (auth)

**45419** NEW METHOD OF ESTIMATING THE CELL CYCLE TIME IN EPITHELIAL TISSUES OF LONG GENERATION TIME. **Brown, J. M.; Oliver, R. (Churchill Hospital, Oxford). Cell Tissue Kinet., 1: 11-21(Jan. 1968).**

A new radioisotope method employing $^{3}$H-thymidine for determining the cell cycle time of the basal layer cells was described and compared with the techniques previously used. This method was based on the rate at which labeled cells left the basal layer and entered the spinous layer above it. Using this technique, the mean cell cycle time of the basal cells was estimated as 130 ± 7 hr; a value that compared favorably with the estimate of 135 ± 17 hr determined with similar assumptions from the length of the S period and the labeling index. The technique enabled an estimate to be made of the fraction of cells in the basal layer that were proliferating (the growth fraction). (BBB)

**45420** FACTORS REGULATING CALCIUM AND STRONTIUM ACCUMULATION IN DAPHNIA MAGNA. Porcella, Donald Burke. Berkeley, Calif., Univ. of California, 1967. 85p. Thesis.

Accumulation of calcium and strontium in Daphnia magna was studied using radioactive tracers. Uptake of these divalent cations is a function of deposition in the exoskeleton and hence is involved in the molting process of this fresh-water crustacean. It is describable by the following equation: $C_t = C_{max}(1 - e^{-k(\alpha+t)})$, where $C_t$ is the concentration at any time (t), $C_{max}$ is the maximum accumulated during the molt cycle, k is the deposition constant, and $\alpha$ is the time prior to molting at which deposition in the exoskeleton begins. Water concentrations of calcium and strontium and size of the Daphnia have no effect on the rate of uptake of calcium and strontium by individual Daphnia. Temperature, metabolic poisons, and prolonged starvation, because of effects on growth rate and molting interval, have great effects on uptake rate. In random populations uptake rates are modified because of the size continuum, a factor which tends to give a continuous spectrum of molting rates and hence deposition rates. Population uptake is the same as for single Daphnia except there is a distribution of deposition rates and the overall rate for populations is much slower. The activation energy of the deposition constants and molting are of the order of oxidative metabolism indicating the involvement with growth rates of the Daphnia. The implications of these facts on other fresh-water biota are discussed and related to the concept of the maximum permissible concentration in water. The conclusion is that the $MPC_W$ for $^{90}$Sr in any fresh-water environment receiving approximately steady-state input of $^{90}$Sr should be related to calcium in the water using the observed ratio model. (Disser. Abstr.)

**45421** CYCLING OF $^{90}$Sr IN MOLTING CRAYFISH. **Dean, John Mark (Battelle Memorial Inst., Richland, Wash.). Comp. Biochem. Physiol., 25: 1113-16(June 1968). (BNWL-SA-1412).**

When crayfish, Pacifastacus trowbridgi, were presented with $^{90}$Sr–$^{90}$Y at a defined stage of the molt cycle (premolt), they stored large amounts in the gastrolith but also deposited some in the old exoskeleton. The radioisotope was cycled between the gastrolith and the exoskeleton after molting. Each week for 5 weeks after eyestalk removal, 1.0 $\mu$Ci of $^{90}$Sr–$^{90}$Y was injected into a sinus at the base of the last walking leg. The activity in the exoskeleton at the first molt was 5.68 nCi/mg dry weight. Thus, a dynamic turnover occurs in this tissue. Muscle had a low level of radioactivity and reflected the amount circulating in the blood. About 10% of the serially administered activity was lost in the first and second molted exoskeletons. After the first molt and after complete hardening of the exoskeleton had taken place, the animals immediately proceeded into premolt. As they resorbed salts from the exoskeleton, the $^{90}$Sr–$^{90}$Y in the carapace was mobilized and concentrated in the new gastrolith thus completing the cycle. Since the fresh-water crayfish is hypertonic to his environment, the animal regulates its internal ionic concentration. This is contrasted with marine species that do not form gastroliths and are able, postmolt, to absorb high levels of Ca from the environment. It was pointed out that deposition of the radioisotope took place in the exoskeleton during the premolt phase while Ca was being resorbed from that site by the animal. (BBB)

**45422** $^{210}$Po ENTRY INTO PLANTS. **Francis, Chester W.; Chesters, Gordon; Erhardt, Wilfred H. (Univ. of Wisconsin, Madison). Environ. Sci. Technol., 2: 690-5(Sept. 1968).**

The possibility that root uptake of $^{210}$Pb from soils is the principal mechanism of $^{210}$Po entry into plants was evaluated and proved to be invalid. If the $^{210}$Pb in the plant is not soil-derived,

the second most likely source is natural radioactive fallout, of which the most important component is from rainfall. Material balances of the quantities of $^{210}Pb$ in tobacco over time intervals of known rainfall indicate rains deposit approximately twice as much $^{210}Pb$ as observed in tobacco leaves, verifying the hypothesis that deposition of $^{210}Pb$ by rainfall is the principal mechanism of $^{210}Po$ entry in plants. (auth)

**45423** THE RADIOINACTIVATION OF RNA. III. AMINO ACID CHANGES FOLLOWING IRRADIATION IN THE DRY STATE. Jung, Horst (Kernforschungszentrum, Karlsruhe, Ger.); Schuessler, Helga. Z. Naturforsch., 23b: 934-43(July 1968). (In German).

Dry ribonuclease was irradiated with $^{60}Co$ $\gamma$ radiation in vacuo, under oxygen atmosphere, and at 77°K. By chromatography on Sephadex G-50 active ribonuclease was separated from inactive radiation products. From the elution pattern and by ultracentrifugation it was shown that unfolded dimers were formed by $\gamma$ irradiation of dry ribonuclease. Amino acid analysis of these various products showed that in all components cystine, methionine, tyrosine, phenylalanine, lysine, and histidine were destroyed with increasing dose whereas glycine showed a small increase. Thus, in ribonuclease irradiated in the dry state the same amino acids were changed as was found after irradiation in aqueous solutions. The radiosensitivity of dry ribonuclease shows an increase by the presence of oxygen of about two and a decrease at low temperature in vacuo of about five. The same factors were also found for the alteration of amino acids, which means that under various experimental conditions amino acid destruction is proportional to loss of enzymatic activity of ribonuclease. The selectivity of amino acid destruction may be explained by energy migration or by the attack of atomic hydrogen liberated at random from the molecule. The total number of amino acids destroyed per ribonuclease molecule increases with dose. In enzymatically inactive products this value is always higher by one amino acid residue than in the active components. From this result and from the increase with dose it is concluded that after destruction of one amino acid residue the ribonuclease molecule has a probability (not depending on dose of irradiation) of 0.45 to become inactivated whereas in 55 per cent of all cases the molecule maintains its enzymatic activity. (auth)

**45424** RADIOINDUCED INACTIVATION OF RIBONUCLEASE AT HIGH TEMPERATURES AND DIFFERENT DOSE RATES. Kuerzinger, Klaus; Jung, Horst (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 23b: 949-61(July 1968). (In German).

The radiosensitivity of dry ribonuclease was determined at various temperatures between 120°K and 440°K using 2 MeV protons. Within this temperature range the inactivation cross section S(T) of ribonuclease may be described as a function of temperature by the expression $S(T) \approx (1.28 + 16 \cdot e^{-1000/RT} + 14{,}000 \cdot e^{-6500/RT}) \cdot 10^{-14}$ cm$^2$. This result indicates that the observed radiation damage to ribonuclease is produced by three different mechanisms, one being independent of temperature, the other two having apparent activation energies of 1 kcal/mole and 6.5 kcal/mole, respectively. From these relatively small activation energies the conclusion may be drawn that radical reactions contribute to the inactivation of enzymes in the dry state. Experiments with Co gamma radiation showed that the radiosensitivity of ribonuclease at 77°K depends on dose rate; at room temperature a dose rate effect was not observed. (auth)

**45425** ON THE X RAY INACTIVATION AT VARIOUS TEMPERATURES OF TRYPSIN IN DRY STATE AND AQUEOUS SOLUTION. Oksmo, Oeyvind; Brustad, Tor (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Z. Naturforsch., 23b: 962-8(July 1968).

The x-radiosensitivity of trypsin was studied both in dry state and in dilute solution (0.1 mg/ml) of $10^{-3}$ N HCl, as a function of the sample temperature during irradiation. Oxygen present during irradiation acted as a sensitizer when the exposure was carried out in frozen aqueous solution as well as in dry state, but it acted as a protector when the enzyme solution was exposed at room temperature. There was considerable indirect effect when trypsin was exposed in frozen aqueous solution, above 200°K, and even at 77°K a small indirect effect was apparent. When trypsin was exposed in $10^{-3}$ N HCl at room temperature about 85 per cent of the indirect effect was eliminated when the solution was saturated with $O_2$, (known as an effective scavenger for $e^{\ominus}_{aq}$ and H) and most of the remaining indirect effect was eliminated if the enzyme solution also contained 100 mM $C_2H_5OH$ (known as an effective $\cdot OH$ scavenger). (auth)

**45426** EFFECT OF $\gamma$-IRRADIATION ON THE CONTENT OF B AND C CYTOCHROMES IN THYMOCYTE NUCLEI. Tarshis, M. A.; Uteshev, A. B.; Kuzin, A. M. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR, 181: 234-6(July-Aug. 1968). (In Russian).

An attempt was made to determine the relation between the variations in nuclear energy and losses of cytochromes observed in the mitochondria of irradiated organs. It was assumed that the close bond between cytochromes and nuclear membrane may offer some data as to the losses or conservation of cytochromes. White male Wistar rats irradiated with $^{137}Cs$ at 1000 R (500 r/min) doses were used. Data on reduced cytochrome content in the nuclei of rat thymus are presented in tabular form. (R.V.J.)

**45427** PRIMING INABILITY OF THE DNA IN CHICK FIBROBLASTS FIXED AFTER IRRADIATION. Liebecq-Hutter, S. (Univ., Liege); Goutier, R. Int. J. Radiat. Biol., 13: 499-501 (1967).

Chick fibroblasts were incubated with calf thymus DNA polymerase, and tritium-labeled deoxyribonucleoside triphosphates of thymine, adenine, guanine, and cytosine were added to the cultures. Some of the preparations were treated with 0.01 N HCl and others were x-irradiated. Autoradiographs show labeling of the HCl-treated cells but not of the irradiated cells. It was concluded that the DNA of x-irradiated chick fibroblasts did not seem to act as primer for the incorporation of nucleotides into the nuclei of fixed cells in the presence of DNA polymerase in contrast to the DNA of fibroblasts treated with HCl. (H.L.W.)

**45428** RESPIRATION AND ACTIVITY OF SOME DEHYDROGENASES IN THE ERYTHROCYTES OF RABBIT BLOOD UNDER THE INFLUENCE OF IONIZING RADIATIONS. Filip, Maria; Ababei, L. (Institutul de Biologie Generale si Aplicata al Filialei Iasi, Iasi). Fiziol. Norm. Patol. (Bucharest), 12: 535-44(Nov.-Dec. 1966). (In Rumanian).

Effects of x irradiation on some metabolic activities of rabbit red cells were studied. The rabbits were given whole-body doses of 950 R. Reticulocytosis was produced by repeated bleedings in some rabbits so that respiratory activity of red cells could be measured. Three hr after irradiation the cells were removed from blood and suspended in 0.9% NaCl. Respiration was measured in the Warburg apparatus and enzyme activities spectrophotometrically. Addition of 2,4-dinitrophenol (DNP) increased respiration 44.5% in normal and 78.0% in irradiated cells. Addition of DNP plus glutamine increased it 66.5% in normal and 18.0% in irradiated reticulocytes. Glucose increased respiration in the presence of DNP to a greater extent in irradiated than nonirradiated cells; the reverse was true with pyruvate + DNP, after a one-hr incubation time. With a longer (four-hr) incubation time both metabolites increased respiration to a greater extent in nonirradiated cells. Ketoglutarate added with DNP was more effective in irradiated cells at both incubation periods. Lactic NAD (nicotinamide adenine dinucleotide) oxidoreductase was increased in irradiated rabbit red cells (9.12 $\mu$mole/ml/min, compared to 7.45 in controls) and to still higher levels in irradiated anemia rabbit cells (11.86 versus 7.65 in anemic nonirradiated controls). Activity of $NADH_2$ oxidase was decreased in irradiated rabbit cells. (BBB)

**45429** INTERFERON SYNTHESIS IN X-IRRADIATED ANIMALS. II. RESTORATION BY BONE-MARROW TRANSPLANTATION OF CIRCULATING-INTERFERON PRODUCTION IN LETHALLY-IRRADIATED MICE. De Maeyer, E.; Jullien, P.; De Maeyer-Guignard, Jaqueline (Institut du Radium, Orsay, France). Int. J. Radiat. Biol., 13: 417-31(1967).

$C_3H$/He mice were exposed to 1000 R whole-body x radiation. Circulating-interferon levels induced in these animals after intravenous injection of Sindbis or Newcastle disease virus were reduced to less than 10 per cent of their normal values. The circulating-interferon-producing capacity could be restored by treatment with isologous bone-marrow cells, immediately after irradiation. The degree of restoration of interferon formation was closely related to the degree of restoration of haemopoietic function, as indicated by experiments where irradiated animals were treated with either a minimal ($2 \times 10^5$) or an optimal ($10^7$) number of isologous marrow cells. This suggested a direct relationship between bone marrow function and the circulating-interferon-producing system. Evidence that circulating-interferon-producing cells are largely derived from bone-marrow was obtained by restoring irradiated $C_3H$/He mice with Wistar rat marrow. In these rat to mouse chimaeras, circulating interferon, induced by either Sindbis or Newcastle disease virus, had the species specific characteristics of rat interferon. (auth)

**45430** EFFECT OF 14 MeV MONOENERGETIC NEUTRONS ON HeLa AND P388F CELLS IN VITRO. Nias, A. H. W.; Greene, D.; Fox, Margaret; Thomas, R. L. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 13: 449-56(1967).

The effects of 14 MeV monoenergetic neutrons were compared

with those of 300 kV x rays. Cell survival data were used to compute dose-response curves from which values of oxygen enhancement ratio (OER) and relative biological effectiveness (RBE) were derived. The OER for HeLa cells was 1.51 with neutrons and 2.39 with x rays, giving a gain factor of 1.58. The RBE for HeLa cells varied between a value of 4.3 at the 90 per cent level of cell survival to 2.3 at the 3 per cent level. The RBE can be assumed to fall to a constant value of 1.95 at lower levels of survival. A constant value of 1.9 was determined for the RBE for P388F mouse lymphoma cells. (auth)

**45431** THE EFFECT OF X-IRRADIATION ON GLYCOLYSIS OF RAT THYMOCYTES. Ohyama, Harumi (National Inst. of Radiological Sciences, Chiba, Japan); Yamada, Takeshi; Kumatori, Toshiyuki; Minakami, Shigeki. Int. J. Radiat. Biol., 13: 457-67 (1967).

The production of aerobic lactate by suspensions of rat thymocytes incubated at 37° was considerably increased after x irradiation. Intracellular concentrations of intermediates and cofactors of glycolysis were measured at different incubation times. Fructose-1,6-diphosphate showed a remarkable increase during incubation. Crossover plot of changes in the levels of intermediates and changes in mass-action ratios for glycolytic reactions have clearly demonstrated the enhanced activity of phosphofructokinase after irradiation. The possible correlation between the activated phosphofructokinase and lactate production was discussed. (auth)

**45432** $^{144}Ce$-$^{144}Pr$ AS A PARTICULATE DIGESTA FLOW MARKER IN RUMINANTS. Ellis, W. C.; Huston, J. E. (Texas A and M Univ., College Station). J. Nutr., 95: 67-78(May 1968).

Radiocerium was evaluated as a particulate digesta flow marker in sheep by comparing its rate of fecal excretion with residues derived from different feedstuff particles upon which the radiocerium had been absorbed and with water-soluble and water-insoluble markers. Radiocerium was adsorbed onto alfalfa by adding 80 $\mu$Ci of $^{144}Ce$-$^{144}Pr$ (carrier free) to 360 g of alfalfa, cut 1 to 8 mm in length, suspended in 500-ml distilled water in a plastic bag. After mixing the water was drained and the hay residues were dried. A single-dose meal was prepared by mixing $\frac{1}{3}$ of the radiocerium-labeled hay residues with 410 g alfalfa hay that was premixed with 10 g polyethylene glycol and 5 g chromic oxide. The mean retention time for radiocerium was related to that for residues derived from feedstuff particles upon which it had been adsorbed and unrelated to that for residues derived from other concurrently fed feedstuff particles. The mean retention time for radiocerium was not significantly correlated with that for a water-soluble and finely divided water-insoluble marker nor was it markedly different when adsorbed either onto hay particles or readily fermentable starch in another experiment. Thus radiocerium remained in close physical association with indigestible residues during their transit of the ruminants' gastrointestinal tract by continued adsorption onto indigestible particles or by readsorption onto other particles. Radiocerium or other rare earth elements at radiocolloidal concentrations were considered as valid flow markers of digesta particulate matter. (BBB)

**45433** INCORPORATION OF URANIUM. I. DISTRIBUTION OF INTRAVENOUSLY AND INTRAPERITONEALLY INJECTED URANIUM. Walinder, G. (Research Inst. of National Defence, Sundbyberg, Sweden); Hammarstroem, L.; Billaudelle, U. Brit. J. Ind. Med., 24: 305-12(1967).

The distribution of U in CBA mice following intravenous and intraperitoneal injections of $^{233}U$-labeled uranyl nitrate and uranyl tricarbonate was studied by autoradiographic and fluorometric methods at different times after administration. A higher retention of U was noted in the spleen and bone than in other organs, including the kidneys. It was shown that even very small amounts of U gave rise to ischemia in the kidney. A higher initial uptake was found in the juxtamedullary zone than in the more peripheral parts of the renal cortex. The retention, however, was higher in the peripheral cortex. This may explain why the first observable damage in the kidney appeared in the juxtamedullary zone. The relation between blood supply and U uptake and retention in different zones of the renal cortex is discussed with particular regard to the toxicological consequences of U incorporation and to the possibility of accelerating the excretion of U. (BBB)

**45434** THE STUDY OF VITAMIN $B_{12}$ ABSORPTION USING LABELED COBALAMINS. Mollin, D. L.; Waters, A. H. Medical Monograph No. 6. Amersham, Eng., Radiochemical Centre, UKAEA, 1968. 24p.

This is one of a series of monographs discussing the clinical applications of radioisotopes. The introduction of cyanocobalamin labeled with radioisotopes of Co made it possible to study the absorption of physiological doses of vitamin $B_{12}$ not only in untreated patients with pernicious anemia, but also in patients following $B_{12}$ therapy. The ease and precision with which $B_{12}$ absorption can be measured using the labeled vitamin has made it possible to study its absorption under physiological conditions in normal subjects and in different malabsorption syndromes. The following aspects are dealt with: physiological aspects of vitamin $B_{12}$ absorption; radioactive vitamin $B_{12}$ (Co radioisotopes, stability and availability of radioactive $B_{12}$); measurement of vitamin $B_{12}$ absorption (fecal excretion method, hepatic up-take method, whole-body radioactivity method, urinary excretion method-Schilling test, plasma radioactivity method); clinical interpretation of vitamin $B_{12}$ absorption tests. (UK)

**45435** ACTION OF $^{131}I$-ROSE BENGAL ON THE VISCERA. Madievskii, Yu. M.; Fedorova, L. I.; Kolesnikova, G. S. (Kharkov Inst. of Medical Radiology). Med. Radiol., 13: No. 6, 31-7(June 1968). (In Russian).

The research was done on 100 rats and 33 rabbits. Under consideration were the following factors: general condition of the animals, histological investigation of the viscera, water content of the tissues, as well as their hydration. Considering elective accumulation of the preparation in hepatic cells subject to measurement were the proportion therein of nucleic acids, glycogen, isoelectric points and of the neutral red sorption figures. $^{131}I$-rose bengal administered in the amount of 2 to 5 $\mu$Ci was shown to elicit a distinct reduction of the brain tissues, small intestine and kidneys hydration, that became most marked at early dates following poisoning. These changes were reversible. Introduction of inactive preparation did not cause any variations of hydration. As evidenced, the liver suffered no changes of sorption capacity with respect to the neutral red and isoelectric points, nor any variations in the DNA, RNA, and glycogen content. Like other organs it demonstrated no morphological alterations. Introduction to the animals of the preparation possessing activity amounting to 0.07 $\mu$Ci was not accompanied by any changes in the viscera according to the characteristics under study. (auth)

**45436** CHANGES IN THE Na, K, Ca, Zn, AND Cu BLOOD CONTENT FOLLOWING RADIATION THERAPY. Fridlyand, I. B.; Ginzburg, M. B.; Kachorovskaya, I. B.; Kalina, V. O. Med. Radiol., 13: No. 6, 28-31(June 1968). (In Russian).

Subject to measurement were the proportions of Na, K, Ca, Zn, and Cu in the blood of patients with cancer of the larynx and superior portion of the esophagus prior to and after beam therapy. With unfavorable results of the treatment K and Na in the blood serum and Zn in the whole blood were found to diminish considerably, the level of Cu in the blood serum, on the other hand, increased. The results of the beam therapy being positive, the proportions of K, Na, and Ca become normal, while Cu content in the blood serum declines, and that of Zn in the whole blood shows a slight increase. (auth)

**45437** BIOLOGICAL EFFECTS OF RADIATION. VOLUME 3. Grebinskii, S. O. (ed.). Biol. Deistvie Radiats., L'vov. Gos. Univ., 3: 3-108(1965). (In Russian).

Fifteen articles are included on biological effects of radiation on the growth, development and metabolism in animals, plants and microorganisms. Ionizing radiation effects on the structure of tropomyosine, transamination and deamination of amino acids in meats, biosynthesis of soluble proteins in lungs, and histochemical changes in the central nervous system of rabbits are discussed in four articles. Effects of x-irradiation on the intensity of $^{35}S$-labeled-methionine incorporation into soluble proteins of rabbit duodenum; effects of ultraviolet and x-radiation on the cholinesterase activity and acetylcholine content of different sections of the brain of rabbits are covered in the next group of articles. The influence of heavy doses of $^{60}Co$ $\gamma$-rays on amino acid composition and the electrophoretic characteristics of soluble proteins in stored meats; effects of x-rays on survival of yeast, Candida melibiosi; effects of x- and $\gamma$-radiation on the yield and ripening of maize and various vegetable seeds are covered in fine articles. The last three articles contain data on x radiation effects on content of phosphorus substances in blood and lymph of dogs; chemical protection against radiation injuries; and protective effects of potassium iodide on the radioresistance and immunity of animals. (R.V.J.)

**45438** ULTRAVIOLET IRRADIATION OF MOUSE L CELLS: EFFECTS ON DNA SYNTHESIS AND PROGRESSION THROUGH THE CELL CYCLE. Domon, M.; Rauth, A. M. (Univ. of Toronto). Radiat. Res., 35: 350-68(1968).

Suspension cultures of mouse L cells were irradiated with ultraviolet light at exposures of 40, 100, and 200 ergs/mm$^2$ which reduced the colony-forming ability of asynchronous cell populations to 95, 70, and 20% of the control value. The rate of DNA synthesis in irradiated cells was found to be temporarily

depressed, but initiation of DNA synthesis as measured by entry of $G_1$ phase cells to S phase was not inhibited. Cell populations irradiated in $G_1$ or $G_2$ phase showed no delay in their movement to S phase or to mitosis, respectively, but cell populations irradiated in S phase had a delay in their progression to $G_2$ phase. Quantitative measurements showed that cell populations irradiated in late $G_1$ or early S phase had a longer delay and a larger fraction of cells that failed to reach mitosis than cells irradiated in late S phase. The fraction of cells that failed to reach mitosis after irradiation was equal to the fraction of cells that lost their colony-forming ability, indicating that whether a cell would survive or not was determined in its first generation after uv irradiation. (auth)

**45439** EFFECT OF pH ON THE FORMATION AND INTERMOLECULAR TRANSFER OF RADIATION-INDUCED UNPAIRED SPINS IN FROZEN AQUEOUS MIXTURES. Pihl, Alexander; Henriksen, Thormod; Sanner, Tore (Norwegian Radium Hospital, Oslo). Radiat. Res., 35: 235-46(1968).

Electron spin resonance (ESP) studies were carried out on frozen aqueous mixtures, containing a macromolecule (Sephadex or Thiogel) and a sulfur compound (reduced or oxidized penicillamine). Prior to freezing, the pH of the solutions was adjusted to 3.8, 7.4, or 9.3. Similar experiments were carried out on the individual components. The samples were irradiated in vacuum at 77°K with x rays to a dose of 0.5 megarad, and the measurements were carried out immediately after irradiation and after subsequent heat-treatments to temperatures in the range 77 to 263°K. After heat-treatment the samples were brought back to 77°K and the spectra were recorded. The intermolecular transfer of unpaired spins from Sephadex or Thiogel to reduced penicilliamine was found to be much greater in the acid than in neutral and alkaline solutions. In contrast, the transfer to oxidized penicillamine was independent of pH. The results indicated that the transfer of unpaired spins from the macromolecule was greater to the undissociated than to the dissociated thiol group, and that hydrogen transfer repair reactions may occur in frozen aqueous mixtures. (auth)

**45440** A COMPARISON OF THE RADIOSENSITIVITY OF THE GASTRIC MUCOSA AT REST AND DURING STIMULATION: SECRETORY, HISTOCHEMICAL, AND HISTOLOGIC STUDIES. Ragins, Herzl; Fried, Marvin; Dombro, Roy; Dittbrenner, Mary; Liu, Sue M.; Johnson, Lawrence; Sanfilippo, Louis (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Amer. J. Dig. Dis., 12: 1256-71(Dec. 1967).

A study was made in dogs of the relation of the secretory state of the gastric mucosa to radiosensitivity. A clinically well accepted dosage schedule was used, that results in healing of most duodenal ulcers within 12 months without apparent damage to small bowel or liver. The midplane x-ray dose was calculated to be 160 R per treatment for total of 1600 R given in 10 treatments over a 12 day period. The following observations were made before, during, and after irradiation: a serial histologic study of the gastric mucosa until it appeared normal again; a parallel intracellular enzymatic histochemical study using acid hydrolases and oxidative enzymatic activities as markers of organelles involved in secretion; and gastric secretion studies in response to a standard dose of histamine (determinations included output of free HCl, $Na^+$, $K^+$, $Cl^-$, total protein, and pepsin). A marked increase in secretion was noted during the period of irradiation. Maximum secretory depression occurred at seven to 14 days postirradiation and all parameters studied returned to normal levels by 28 to 46 days. No differences could be detected between dogs in which the stomach was at rest (R) or secreting (S) at the peak of its response to histamine when the stomach was irradiated. Serial intracellular enzymatic histochemical studies demonstrated activity of acid phosphatase, thiamine pyrophosphatase, and $NADH_2$ tetrazolium reductase. While the effects of injury were evident by days three to 10, these histochemical methods did not reveal alterations in lysosomes, Golgi zones, or mitochondria prior to the histologic appearance of cell destruction. Serial histologic examinations of multiple biopsies showed patchy destruction appearing by days three to 10, and double-blind examination of the sections revealed no difference in the radiosensitivity of the R and S dogs. All biopsies returned to normal in 30 to 60 days. Radiosensitivity of the canine gastric mucosa appears to be unaltered by its functional (secretory) state. (BBB)

**45441** UV PHOTOCHEMISTRY OF CYTIDYLIC ACID. Becker, H.; LeBlanc, J. C.; Johns, H. E. (Univ. of Toronto). Photochem. Photobiol., 6: 733-43(Oct. 1967).

Ultraviolet irradiation of the 3′ isomer of cytidylic acid (Cp) produced the hydrate ($Cp^*$), with water added across the 5-6 double bond. The yield of this photoproduct was measured by separating the photoproduct by electrophoresis and also by observing the loss in absorbance. When corrections were made for reversal of the hydrate during the experiment, both methods gave the same result. Cross sections and quantum yields for the production of the hydrate were measured over the wavelength range 220 to 290 nm and over a pH range from 1 to 10. The quantum yield was markedly dependent on pH, being higher by a factor of six to 10 for the neutral form. Existence of a very short-lived photoproduct (half life 8 to 9 min) in both Cp3′ and Cp5′ was demonstrated. The nature of this short-lived product was not determined. (BBB)

**45442** EFFECT OF X RAYS ON THE ACTIVITY OF ISOLATED HIPPOCAMPUS NEURONS. Popova, L. A.; Shlyafer, T. P. (Inst. of Experimental Medicine, Moscow). Dokl. Akad. Nauk SSSR, 180: 758-60(May 21, 1968). (In Russian).

The bioelectric impulses of individual hippocampus neurons of anesthetized rabbits (0.75 g of urethane per kilogram of body weight) were studied before and after 700 R of x irradiation. Glass microelectrodes containing 0.6 M $K_2SO_4$ were used. Stimuli, applied for 6 sec, were a bell, a pure tone, ammonia fumes, touching of the animal's muzzle, and pricking of the skin along the spine. The impulses recorded for the animals before and after x irradiation showed that irradiation changed the activity of the hippocampus cells by decreasing their excitability and distorting their response to sensory stimuli. Results indicated that the x radiation acted directly on the hippocampus or indirectly through reticular formation and septo-hippocampal paths. (TTT)

**45443** RADIATION-CHEMICAL FORMATION OF AMINO ACIDS BY CARBOXYLATION AND AMINATION. Dose, Klaus; Risi, Sergio (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Z. Naturforsch., 23b: 581-7(May 1968). (In German).

The formation of aliphatic $\alpha$-amino acids by x ray induced carboxylation of simple amines or amination of simple carboxylic acids is not favored over the formation of other amino acids. The new carboxylic and amino groups are more or less distributed statistically over the carbon atoms of the starting material. On radiationchemical formation of aliphatic hydrocarbons over $C_3$, therefore, an increasing amount of unusual amino acids is produced. The results are influenced by various parameters such as temperature, pH, concentration, linear energy transfer and total doses of radiation applied. Peptides can also be formed radiationchemically. However, the formation of greater molecules by radiationchemical processes under the conditions of a primitive earth seems to have only a low probability. The reaction mechanisms of radiationchemical carboxylation and amination are discussed. (auth)

**45444** INFLUENCE OF STRUCTURALLY DIFFERENT FATS IN DIET ON THE METABOLISM OF NUCLEIC ACIDS IN IRRADIATED RATS. Nemec, R.; Ginter, E. (Inst. of Human Nutrition Research, Bratislava). Nutr. Dieta, 9: 300-8(1967).

Male Wistar rats were placed on synthetic diets with an extremely different content of unsaturated fatty acids in the fat component. In diet I the fat component was represented by highly saturated coconut oil (iodine number 12.5) and in diet II by highly unsaturated linseed oil (iodine number 178.4). After consuming the diet for 21 days, the rats were x irradiated at a single whole-body dose of 600 R. Fifteen min after irradiation, the animals were given intraperitoneally $Na_2H^{32}PO_4$ in a dose of 0.2 $\mu$Ci/g body weight and were then decapitated at intervals of 24, 48, and 96 hr following irradiation. The spleens were homogenized and four fractions prepared: acid-soluble phosphorus, lipid phosphorus, RNA, and DNA. The level of DNA in the spleen fell sharply after irradiation in both diet groups. Incorporation of $^{32}P$ into the lipid phosphorus fraction was significantly increased in animals given coconut oil at all time intervals after irradiation, contrary to the nonirradiated controls. In rats given linseed oil, after a transitory fall in $^{32}P$ incorporation 24 hr after irradiation, there was a significant rise at all the subsequent time intervals. In groups fed saturated coconut oil $^{32}P$ incorporation into RNA was significantly higher than in groups fed linseed oil. Incorporation of $^{32}P$ into DNA was markedly affected by irradiation. In both groups of animals, a significant fall was recorded at 24 and 48 hr following irradiation but not in the nonirradiated groups. These results demonstrate that the metabolism of nucleic acids in the spleen of rats is more markedly influenced when the animals are given, as the source of fat, linseed oil containing a high percentage of unsaturated fatty acids before irradiation. In animals fed on coconut oil, the changes were less. (BBB)

**45445** CLEAVAGE OF THYMINE DIMERS IN ESCHERICHIA COLI BY FAST ELECTRONS. Greulich, V.; Hartmann, D.; Schmidt, B. (Freie Univ., Berlin). Z. Naturforsch., 23b: 753-4(May 1968). (In German).

Carbon-14-labelled thymine was used to study the radioinduced cleavage of thymine dimers in Escherichia coli to monomeric

thymine dimers. The amount of cleavage in nonirradiated bacteria, uv-irradiated bacteria, and uv- and fast electron-irradiated bacteria (34 MeV) was determined. Paper chromatography was the method used for determining the content of dimers. (B.S.L.)

**45446** KINETICS OF RADIOINDUCED HYDROGEN CLEAVAGE FROM URACIL. Heitkamp, D.; Merwitz, O. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 23b: 479-81(May 1968). (In German).

It is shown that the recent kinetic reaction model formulated for thymine is, in principle, applicable to the description of hydrogen cleavage from uracil under $^{60}Co$ $\gamma$ irradiation in the dose range from $10^5$ to $8 \times 10^6$ rad. (tr-auth)

**45447** BIOCHEMICAL EFFECTS OF IONIZING IRRADIATION ON NUCLEAR FUNCTION IN ANIMAL CELLS. Ord, Margery G.; Stocken, L. A. (Oxford Univ.). Proc. Roy. Soc. Edinburgh, Sect. B, 70: 117-24(1968).

Biochemical lesions produced in animal cells by ionizing radiation are considered on the basis of the immediate response to doses of 100 rad or less in rat thymus gland and regenerating liver. In these organs the ultimate damage to the cell evidently stems from an initial derangement of the nuclear thiol-disulfide equilibrium. Reduction in DNA synthesis is an immediate response to irradiation; in the thymus gland, inhibition of $^{32}PO_4$ uptake into DNA was noted between three min and two hr after exposure. Generation of nuclear ATP is extremely sensitive to low doses of radiation, not only in thymus but also in other dividing tissues. It is suggested that oxidation of thiol groups is an important factor in the primary radiation lesion in animal cells and that the relevant thiol groups are confined to the nucleus, with cytoplasmic thiol groups much less significantly concerned. Oxidized glutathione in concentrations of $10^{-3}$ to $10^{-4}$ M mimics the effects of irradiation by inhibiting nuclear phosphorylation, nuclear protein synthesis, and nuclear RNA synthesis. Studies on thymus nuclei showed that oxidation of thiols produced by irradiation may be reversed in the presence of glutathione reductase by using the NADPH produced in the cytoplasm, although it is not known whether the original configuration of the thiol proteins can be restored. Radiation effects on the cytoplasm are also considered since there is well-documented evidence for damage to mitochondria. However, it is believed that this damage is likely to be of greater importance in impeding the recovery processes rather than in contributing to the initial, nuclear disturbance. (BBB)

**45448** CELLULAR IMMUNITY AND THE HOMOGRAFT REACTION. Brent, L. (Univ. of Southampton, Eng.); Medawar, P. B. Brit. Med. Bull., 23: 55-60(Jan. 1967).

Manifestations of hypersensitivity to homografts in guinea pigs and normal and immune lymphocyte transfer (NLT and ILT) reactions were reviewed. The reaction excited in irradiated (600 R) guinea pigs by the intradermal injection of normal allogeneic lymphocytes (the NLT reaction) starts with a first inflammatory episode which reaches its peak at 24 hr, and is succeeded between the third and fourth days by a flare-up leading to a second and more violent inflammatory episode which reaches its peak at about 6 days. The lesion then quickly disappears as a result of the immunological recovery of the host. When specifically presensitized cells are substituted for normal lymphocytes, the sequence of reactions is identical except that it is transposed into a higher key; the ILT reaction starts at the level which the NLT reaction achieves only at its second peak. The NLT and ILT reactions were used to reveal the effects of x rays and $\gamma$ radiation on the immunological performance of lymphoid cells. The effect on presensitized lymphoid cells of exposure to 1000 R of $^{60}Co$ $\gamma$ irradiation was examined. Sets of $6.5 \times 10^6$ sensitized cells from a homogeneous population were injected first on one side of the body and then on the other side, with exposure to radiation between infections. For three days the reactions of the two sets of cells were indistinguishable, though one had been exposed to 1000 R, but irradiation abolished the flareup. In the NLT reaction, doses up to 1000 R did not affect the first inflammatory episode, but did profoundly depress the flare-up. (BBB)

**45449** NATURAL AND ACQUIRED IMMUNOLOGIC UNRESPONSIVENESS. Weigle, William O. Monographs in Microbiology. Cleveland and New York, The World Publishing Company, 1967. 189p.

Mechanisms involved in autoimmunity and in artificially induced immunologic unresponsiveness are examined. Studies on the effects of physical (radiation) and chemical agents on induction and maintenance of the unresponsive state, the termination of immunologic unresponsiveness, and the results of experiments to induce immunologic unresponsiveness to heterologous thyroglobulin are included. (B.S.L.)

**45450** RADIORESISTANCE AS A MEASURE OF INTERACTION OF HUMAN LYMPHOCYTES. Schrek, Robert (Veterans Administration Hospital, Hines, Ill.). Arch. Pathol., 85: 31-5 (Jan. 1968).

The interaction of blood cells in mixed cultures is considered as an expression of the histocompatibility of two persons and as a guide for the selection of donors for organ transplants. Mixed lymphocyte suspensions were studied for the capacity of the cells to transform into lymphoblastoid cells and to resist x irradiation. A slide chamber method was used to count viable lymphocytes and transformed cells. The results indicated that transformed and transforming lymphocytes in mixed cultures were radioresistant. The number of cells resisting irradiation with 100 R in mixed cultures was found to be a measure of the capacity of the lymphocytes to interact. A one-way reaction was measured by the number of surviving cells in mixed cultures when one suspension was irradiated with 1000 R and the other with 100 R. The bidirectional interaction of lymphocytes in mixed cultures was found to be equal to the sum of two unidirectional reactions. The paired experiments measured two unidirectional reactions while the work with the mixed suspension measured the combined interactions of the two suspensions. Theoretically, the bidirectional interaction (I) of lymphocytes in the mixed suspensions should equal the sum (S) of the two unidirectional reactions and the ratio of S:I should be one. Experimentally, the average ratios were 1.43 and 0.89 with the two methods of measuring lymphocytic reactions. (BBB)

**45451** THE RADIOAUTOGRAPHIC DETERMINATION OF $^{99m}Tc$. Stoecker, E.; Boerner, W.; Moll, E. (Univ., Wuerzburg, Ger.). Klin. Wochensch., 44: 470-1(Apr. 15, 1966).

A method for high resolution autography of $^{99m}Tc$ deposited in tissue sections is described. The method is based on the detection of the conversion electrons produced in 8.7% of the decay emission spectrum. The conversion electrons have a single energy of 0.14 MeV with a range of ~250 $\mu$ in tissue. Their range in the film emulsion is ~ 90 $\mu$, so that adequate resolution can be obtained. Although the $\gamma$ irradiation emitted by $^{99m}Tc$ is much greater, its half value thickness in tissue is ~4.6 cm and its range in film emulsion is ~0.7 cm, so that a clear image of the radiation cannot be obtained. Slides were prepared from an axillary tumor from a patient who had received an intravenous injection of 2 mCi of $^{99m}Tc$ 2 hr previously. The sections were prepared in a cryostat with an average thickness of 10 $\mu$. Kodak AR 10 stripping film with emulsion thickness of 5 $\mu$ was used, and the sections were exposed for up to 40 hr, developed for 4 min at 20°C, fixed for 20 min at 20°C, and stained with hematoxylin-eosin. (BBB)

**45452** EFFECT OF $D_2O$, GLYCEROL, ALIPHATIC ALCOHOLS, AND THE POSSIBLE ROLE OF HYDROPHOBIC INTERACTIONS IN ELECTRON TRANSPORT IN MITOCHONDRIA. Kalinichenko, L. P.; Khristova, M. L.; Shnol, S. E. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Biophysics (USSR) (Engl. Transl.), 12: 947-52(1967).

Translated from Biofizika, 12: 824-8(1967).

The effect of $D_2O$, glycerol, and aliphatic alcohols on the rate of $O_2$ uptake by rat liver mitochondria was determined. When the mitochondria were placed in a reaction mixture in which the concentration of $D_2O$ was 87%, the rate of $O_2$ uptake was reduced to 50% as compared with that in 10.0% $H_2O$; the rate fell monotonically with the rise in $D_2O$ concentration. The rate of $O_2$ uptake in a medium containing ~20 to 30% glycerol was not affected; reduction in $O_2$ uptake was observed at concentrations of 30% or more. The viscosity of $D_2O$ was not of fundamental importance for respiratory depression; a 12% solution of glycerol had the same viscosity as 99% $D_2O$. To determine if $D_2O$ slowed down electron transfer at all portions of the mitochondrial respiratory chain or at the narrow sites where the formation of hydrogen ions are significant, $\alpha$-ketoglutaric, malic, citric, ascorbic, succinic, and $\beta$-hydroxybutyric acids were used as substrates. Neither $D_2O$ nor 50% glycerol led to significant changes in the degrees of reducibility of cytochrome b or c. Study of the effects of different concentrations of aliphatic alcohols on the $O_2$ uptake showed that the longer the carbon chain, the smaller the concentration that could be used to produce the same (40%) depression of mitochondrial respiration. The possibility that the hydrophobicity of the alcohols was responsible for their effect on $O_2$ uptake is discussed. (B.S.L.)

**45453** ASSIMILATION AND DISTRIBUTION OF RADIOACTIVE PHOSPHORUS IN PLANTS OF INBRED MAIZE LINES AND IN THEIR HYBRIDS. Istatkov, S.; Mladenova, Y. (Inst. of Genetics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 485-8(1968).

The assimilation of $^{32}P$ by inbred lines and hybrids of maize was studied at 100 and 500 $\mu$Ci/l concentrations. Results of the 100 $\mu$Ci/l experiments indicated that the relative assimilation of $^{32}P$ by the plants as a whole was higher in the parent forms than

it was in the hybrids. The highest accumulation of $^{32}P$ was observed in the roots of the plants of all variants; the lowest, was in the leaves. Phosphorus accumulation in the surface parts of the plants was not related to the amount assimilated by the roots. At 500 μCi/l of $^{32}P$, heterotic plants assimilated P most intensely. A more intense move of P towards the surface ports of the plants was observed. It was concluded that one of the components of the crossing differed essentially from the other in the relative accumulation of P in the leaves and in the activity of assimilating P per unit of root mass. Also, the 500 μCi/l concentration of $^{32}P$ had a certain inhibiting effect on the root system of all plants; the effect was more marked in the plants of the inbred lines. (B.S.L.)

**45454** $^{137}Cs$ LEVELS IN PLACENTAE. **Takeshita, Kenji; Antoku, Shigetoshi; Sunayashiki, Tadashi; Tabuchi, Akira; Nakao, Yukinori (Hiroshima Univ.). Hiroshima J. Med. Sci., 16: 153-61 (June 1967).**

Since February, 1966, $^{137}Cs$ levels in placentae in Hiroshima hospitals were measured, and, with corrections, it was possible to estimate the total body burden of $^{137}Cs$ from these data. The average $^{137}Cs$ levels for all placentae analyzed was 38.1 ± 30.6 pCi/Kg. Those in placentae of stillborn fetuses were slightly higher than in normal placentae but the difference was not statistically significant. Monthly averages of $^{137}Cs$ levels in placentae increased from November 1966 to January 1967, while no such an increase was observed in urine. The average total-body burden estimated from $^{137}Cs$ levels in placentae was 3.0 mμCi. It was calculated using a value of 0.69 for the ratio of $^{137}Cs$ levels in placenta and the maternal body. Total-body burdens estimated from postpartum urine agreed with that estimated from placentae. Total-body burden of Japanese adult men has been variously reported in 2 studies as 6.7 mμCi and 8.1 mμCi in 1966. (BBB)

**45455** NERVE FIBER BEHAVIOR IN HEAVY WATER UNDER VOLTAGE-CLAMP. Conti, F.; Palmieri, G. (Univ., Genoa). Biophysik, 5: 71-7(1968).

The effect of $D_2O$ on the excitation properties of squid giant axons was studied with the voltage-clamp technique. A decrease by a factor 1.4 in the amplitude of the maximum inward and outward currents was observed together with an increase, by about the same factor, in the time constants. The results were in agreement with the known observation that $D_2O$ has no effect on the amplitude of the spike, since the currents measured during voltage clamp have a direct influence on the rate of change in the rising and falling phases, rather than on the amplitude of the action potential. (auth)

**45456** ABSORPTION OF $^{140}Ba$, $^{89}Sr$, AND $^{45}Ca$ BY BONE TISSUE. Popov, D. K.; Mikhailova, A. I. Radiokhimiya, 10: 393-5(1968). (In Russian).

Curves were constructed for absorption of $^{140}Ba$, $^{89}Sr$, and $^{45}Ca$ by bone tissue preparations. The influence of $La^{3+}$ on the uptake of $^{140}Ba$, $^{89}Sr$, and $^{45}Ca$ by whole bone preparations was analyzed. Data obtained on comparative uptake of isotopes by various bone tissue preparations are tabulated. It was postulated that secondary absorption plays an important part in the uptake of isotopes. (R.V.J.)

**45457** EFFECTS OF $^{137}Cs$ AND $^{90}Sr$ ADMINISTERED CONTINUOUSLY AND THROUGH GENERATIONS UPON MICE. V. Nishio, Kazuo; Megumi, Tsuneo; Yonezawa, Morio. Annu. Rep. Radiat. Center Osaka Prefect., 8: 123-8(1967).

Effects of $^{137}Cs$ and $^{90}Sr$ were researched in respect to abnormality of growth, reproduction, life span, and tolerance against x irradiation and transplanted Ehrlich ascites tumor cells in mice of NA-2 strain continuously administered these isotopes through the 10th generation. Mice fed with water containing 0.4 μCi of $^{137}Cs$ and 0.1 μCi of $^{90}Sr$ per ml (Group I) lost reproductive function in the second generation. Group II mice (fed with 1/10 dose of isotopes of Group I) showed shortening of average life-span, inferiority of number of litters, slight increase in tolerance against 700 R of x irradiation, and no increase in tolerance against transplanted Ehrlich ascites tumor cells. The ratio of male to female of reproduced litters was smaller than that of the control (Group IV). In mice of Group III administered 0.004 μCi of $^{137}Cs$ and 0.001 μCi of $^{90}Sr$ per ml, lengthening of life-span, superiority in total number of litters, and higher sex ratio (♂/♀) were observed. The tolerance against transplanted Ehrlich ascites tumor cells seemed to be better than that of the control. The tolerance against 700 R of x irradiation was much better than that of the control. It was remarkable that the survival rate of Group III mice was twice in males and six times in females. This tolerance against x irradiation was obtained when the control mice were administered the same concentration of radioisotopes as Group III immediately after birth until 7 weeks old. It was another valuable finding that the sex ratio (♂/♀) increased and then decreased according to the increase of the administered isotope dose. (auth)

**45458** THE EFFECT OF ROENTGEN IRRADIATION ON THE SPECIFIC FLUORESCENCE OF EPIDERMAL MELANOCYTES. **Olivecrona, H.; Korsman, H. (Univ. of Lund, Sweden). Acta Dermato-Venerol., 46: 403-5(1966).**

After different kinds of irradiation, uv- and x-ray, melanocytes enlarge and become branched, and these stimulated cells can then convert tyrosine to melanin in vitro. Since tyrosinase activation in the melanocytes may result in accumulation of DOPA, it was of interest to analyze the effect of radiation on the specific fluorescence of the basal melanocytes. Eleven Caucasians who received x-ray treatment of the axilla because of malignancy were studied. The daily skin dose was 300 or 350 rad and the total dose varied between 2800 and 3500 rad. On the last day of treatment, biopsies were taken from the treated and untreated axilla. All patients initially showed erythema followed by hyperpigmentation of the irradiated area. The number and morphology of the melanocytes in the normal skin and the intensity of their fluorescence differed widely from one individual to another. However, in all the skin specimens taken from the irradiated area the number of fluorescent (i.e., DOPA-containing) melanocytes was higher than in normal skin and the intensity of the fluorescence was clearly increased. The irradiated skin showed an increase in the cell body size of the melanocytes that had longer, wider, and more branched dendritic processes. (BBB)

**45459** STUDIES ON SYNTHETIC HYDROXY APATITE CRYSTALS WITH REGARD TO METABOLISM OF CALCIUM, STRONTIUM, BARIUM, AND RADIUM IN BONE. II. SURFACE BINDING ENERGY AND RETENTION FUNCTION. Stark, G. (Univ. des Saarlandes, Homburg, Ger.). Biophysik, 5: 55-65 (1968). (In German).

Influenced by a chain of mechanisms the time course of incorporated radioactive alkaline earths in bone is determined by the slowest link. This is given by the exchange of the anorganic crystals of bone with the surrounding solution. A suspension of hydroxy apatite crystals was used to try and explain the power function in the form of a mathematical description of retention of alkaline earths in bone in physical terms. It results from superimposing first order reactions caused by a distribution of binding energies of the ions to the crystal surface. (auth)

**45460** RELATIVE SENSITIVITY OF LEUKOCYTE INTERPHASE STAGES TO X-IRRADIATION AND THE DOSE-RESPONSE RELATIONSHIPS FOR EACH STAGE. Shepard, June Smith. Madison, Wis., Univ. of Wisconsin, 1967. 116p.

Thesis.

To measure sensitivity of leukocytes to x irradiation during interphase stages, freshly drawn blood cells were placed in culture and irradiated immediately, at 48 hours, and at 69 hours. Colcemide was added to all samples at 71 hours to collect metaphase cells for one hour preceding fixation. The first sample (0 hour) represented cells irradiated during $G_1$ (the pre-synthetic period), the second sample (48 hour) represented cells treated during S (the DNA synthetic period), and the third sample (69 hour) with fixation 3 hours later represented cells treated during $G_2$ (the post-synthetic period). Sensitivity was measured by recording all chromosome or chromatid deletions, exchanges and gaps noted during karyotype analysis of the metaphase plates that had been stained and coded. These determinations were made at three dose levels (50r, 100r, 200r) on cells from three individuals. The accuracy of the stages sampled was checked by running parallel cultures with tritiated thymidine, by other labeling experiments, and by determining the mitotic index at a series of intervals following the 200r dose (in samples without colcemide). These tests indicated that the 69 hr sample fixed at 72 hours did not contain either prophase of S stage cells and did consist largely of late $G_2$ cells. It was found that the frequency of x-ray-induced open breaks (terminal deletions) was higher in each successive stage of interphase ($G_1$, S, $G_2$) in human leukocytes. However, when damage was measured in terms of two-hit aberrations (which require rejoining) high frequencies were observed during $G_1$ and $G_2$; a much lower frequency during S. S stage cells also showed decidedly fewer anaphase bridges than $G_2$ cells. At low doses (50r) $G_1$ and $G_2$ were about equally sensitive; at higher levels (100r) $G_1$ was more sensitive than $G_2$. During $G_1$, one-hit aberrations were proportional to the dose, and two-hit aberrations followed a dose exponent of 1.5. During S, deletions approximated proportionality to dose, but exchange frequency appeared independent of dose. During $G_2$, the one-hit aberrations increased exponentially, while two-hit aberrations increased linearly. This exactly reversed the kinetics shown by $G_1$ cells. It is discussed in detail how the above results can be interpreted as reflecting a less efficient repair system during S and $G_2$ rather than differ-

ences between stages in the original number of primary breaks per nucleus. There were statistically significant differences in irradiation response by different subjects. The distributions of break-points for both deletions and misunions were found to be non-random, however, no general correlation for breakage or reunion with heterochromatic regions was demonstrated. (Diss. Abstr.)

**45461** HYDROXYALKYL PEROXIDES AND THE TOXICITY OF IRRADIATED SUCROSE. Schubert, Jack; Watson, Joseph A.; White, E. Roderick (Univ. of Pittsburgh). Int. J. Radiat. Biol., 13: 485-9(1967).

Test organisms (Salmonella typhimurium $LT_2$) were grown in a synthetic medium containing 0.05% glucose as a carbon and energy source. Given amounts of $^{60}Co$ γ-irradiated sucrose solutions were added to the basal medium with the organisms, and growth measurements were made. It should be noted that no contribution was made by the sucrose to the growth of the organisms when glucose was present, nor did growth occur when sucrose alone was the carbon and energy source. Growth was inhibited by the addition of irradiated, buffer-free, oxygenated sucrose solutions, and to a far less extent by sucrose solution irradiated in helium. Addition of $H_2O_2$ to the latter solutions enhanced the inhibiting effects even though the added $H_2O_2$ was consumed. $H_2O_2$ added in conjunction with glyoxal or other carbonyl compounds formed in the radiolysis of carbohydrates were highly inhibitory. The degree of inhibition was a function of the concentration of the molar ratio of $H_2O_2$ to carbonyl compounds. The results indicate that the toxicity of irradiated oxygenated sucrose was derived from but not due to $H_2O_2$. The hydroxyalkyl peroxides derived from the interaction of radiolytic $H_2O_2$ with carbonyl compounds produced in the radiolysis of sucrose are strongly implicated in the effects. (E.R.B.)

**45462** ALTERATION OF THE MICROWAVE SATURATION BEHAVIOUR AFTER HEAT TREATMENT IN ELECTRON SPIN RESONANCE STUDIES OF FREE RADICALS PRODUCED IN DL-VALINE BY X-IRRADIATION. Schnepel, Gerd Henning (Univ., Freiburg i. B. Univ., Giessen, Ger.). Biophysik, 5: 85-7(1968).

Polycrystalline d,l- valine was x irradiated at room temperature at a dose rate of 0.21 $Mrad/min^{-1}$ for a total dose of 100 Mrad. Electron spin resonance (ESR) measurements were carried out before and after heat treatment for 9 hr at 80°C. After heat treatment of the x-irradiated valine, the ESR spectrum showed a more resolved hyperfine structure than before. A similar effect was obtained with samples irradiated with 1 Mrad. The microwave saturation effect produced by large values of the microwave field strength changed the linear relation between the intensity of the spectrum and the field strength. Before heat treatment of the irradiated d,l-valine the saturation was obtained at higher microwave field strength whereas after heat treatment it occurred at lower field strength. It was concluded that the two species of free radicals had a different spin-lattice interaction time and that their numerical proportion was a function of x-ray absorbed dose; the heat treatment may have caused a quicker change. (B.S.L.)

**45463** RADIOBIOLOGICAL STUDIES ON THE ROLE OF STRAND SCISSION IN THE INACTIVATION OF DNA. Summers, William Cofield. Madison, Wis., Univ. of Wisconsin, 1967. 146p.

Thesis.

A relatively simple and rapid method was developed that allowed the quantitation of the rate of production of single-strand scission in polydisperse populations of DNA molecules. This method, which is based on determination of the loss of renaturability of cross-linked DNA, was applied to measuring strand breakage by ionizing radiation and by DNAase I. Radiosensitivity to single-strand scission was proportional to molecular size but was independent of average base composition or substitution of bromouracil for thymine. The protective effects of cysteine, cysteamine, and higher DNA concentration were demonstrated. Biological studies were carried out to relate the number of single- and double-strand breaks in DNA to the rate of inactivation of Bacillus subtilis transforming DNA, transfecting (infectious) phase DNA, and free phage. Transforming DNA (indole marker) seemed to be inactivated by single-strand scissions since one mean inactivation dose ($D_{37}$ = 4 krad) produced an average of one single-strand break per $4 \times 10^6$ m wt. (40 μg/ml buffer) which was in good agreement with independent estimates of the size of the DNA fragment involved in B. subtilis transformation. On the other hand, both transfecting phage DNA and free phage seemed to be inactivated by double-strand breaks. The $D_{37}$ for transfecting DNA (10 μg/ml buffer) from a small B. subtilis phage φ29 was about 6 krad. Sedimentation data indicated that the number of double-strand breaks were proportional to the loss of infectivity. Plaque-forming ability of the free phage was also lost at the same rate ($D_{37}$ = 7 krad) as the production of double-strand scissions in DNA extracted from irradiated phage. (Disser. Abstr.)

**45464** USING THE MATHEMATICAL-STATISTICAL METHOD TO ESTABLISH THE ULTRASTRUCTURAL DIMENSIONS OF THE MITOCHONDRIA IN OVOCYTES OF OVARIES OF MICE IRRADIATED WITH IONIZING RAYS. Hadjiolov, A. I.; Boyadjieva-Mihailova, A.; Boneva, L. Compt. Rend. Acad. Bulg. Ser., 21: 489-92(1968).

In vivo radiation effects on the size of the mitochondria and endoplasmic reticulum of ovarian cells of mice were studied. The method used for treatment of photomicrographs in a mathematical-statistical manner to determine the mass of the mitochondria and the endoplasmic reticulum is described. It was concluded that this method made it possible to obtain quantitative results of a much more significant character than the results obtained from ordinary morphological description. (B.S.L.)

**45465** COAGULATION-FIBRINOLYSIS SYSTEM AND INTRACAVITARY RADIUM THERAPY. Takano, Atushi (Hirosaki Univ., Japan). Hirosaki Igaku, 19: 411-25(Nov. 15, 1967). (In Japanese).

Whether intracavitary radium therapy influenced the blood coagulation-fibrinolysis system or not was studied using routine analyzing procedures on 46 patients with carcinomas of either the uterine cervix or vagina. The intracavitary radium therapy used was a modification of the Stockholm method. Coagulability was elevated during the intracavitary radium therapy. This elevation was marked particularly in the values of r and k in thrombelastograms and in the fibrinogen concentration. No significant change was observed in the fibrinolysis system except in some patients with complicated radiation sickness. In these patients, an elevation was observed in the spontaneous caseinolytic activity of euglobulin fraction. An intense fibrinolytic activity was observed, however, in the thrombelastogram of the uterine vein blood. This finding seemed to indicate that the behavior of the coagulation-fibrinolysis system in utero cannot always be determined by an analysis of the cubital vein blood. (auth)

**45466** INVESTIGATION OF FREE RADICALS IN γ-IRRADIATED STARCH BY THE METHOD OF ELECTRON PARAMAGNETIC RESONANCE. Abagyan, G. V.; Krutova, Yu. N.; Putilova, I. N.; Butyagin, P. Yu. (Inst. of Chemical Physics, Moscow. Moscow Technological Inst. for the Food Industry). Biophysics (USSR) (Engl. Transl.), 12: 943-6(1967).

Translated from Biofizika, 12: 820-3(1967).

The EPR spectra of free radicals appearing for low-temperature (-196°) γ-radiolysis of corn starch were examined. Samples were irradiated at doses of 0.047 to 2 Mrad at a dose rate of 440 rad/sec in atmospheres of dry air or pure oxygen or under a vacuum ($10^{-3}$ mm Hg), and were observed over the temperature range of -196° to +150°C; the time of holding at each specified temperature was 10 min. The initial complex EPR spectrum observed at -196°C consisted of a quadruplet with splitting $a_H = 19 \pm 1$ oe, doublet with $a_H = \pm 1$ oe, and a small admixture of a single signal of width $\Delta H = 10 \pm 1$ oe. On heating the samples in vacuo over the temperature range -20° to +30°C, the spectrum was transformed: the lines corresponding to the quadruplet spectrum vanished with simultaneous increase in the lines of the doublet with no change in the total concentration of free radicals in the spectrum. In the presence of oxygen the nature of the transformation of the EPR spectra did not change but the total concentration of radicals fell. It was assumed that the EPR signal of the four components of the ultrafine structure corresponded to radicals with a free valence at the fifth carbon of the monomer link. (B.S.L.)

**45467** EFFECT OF IRRADIATION ON THE PASSIVE TRANSFER OF DELAYED HYPERSENSITIVITY. Asherson, G. L.; Loewi, G. (London Hospital Medical Coll.). Immunology, 13: 509-12(Nov. 1967).

Both the induction and eliciting of delayed hypersensitivity reactions showed considerable resistance to irradiation. Data are presented on the ability of lymph node and peritoneal exudate cells to transfer delayed hypersensitivity after irradiation in vitro. Lymph node and peritoneal exudate cells were taken from guinea pigs three weeks after immunization with 500 μg of bovine γ-globulin in Freund's complete adjuvant. The cells were suspended in 3% inactivated normal guinea-pig serum and x irradiated at doses of 250 to 3000 R. Then the cells were injected intravenously into recipients and delayed hypersensitivity reactions were read 25 hr later. Radiation doses of less than 1000 R had no effect on passive transfer; however, 1500, 2000, and 3000 R reduced the mean diameter of the delayed hypersensitivity lesions to bovine γ-globulin and PPD (purified protein derivative of tuberculin). This was true for both lymph node and peritoneal exudate cells. For instance, 3000 R reduced the reaction to PPD transferred by lymph node cells by a factor of 2.9 and the delayed hypersensitivity transferred by peritoneal exudate cells by a factor of 1.9. The

induration associated with passively transferred delayed hypersensitivity was also reduced by irradiation in vitro. Histological examination of the passively transferred delayed hypersensitivity lesions also showed that passively transferred delayed hypersensitivity to PPD was reduced by irradiation of the cells in vitro. Irradiation had little effect on the histology of the reactions to bovine γ-globulin. This was because at 24 hr there was appreciable polymorph and mononuclear infiltration due to serum alone and the additional effect of transferring cells with the serum did not become large until 48 hr. (BBB)

**45468** RESPONSE OF ANTIBODY PLAQUE-FORMING CELLS AFTER IRRADIATION. Roeseler, P. H.; Stender, H. St. (Medizinische Hochschule, Hanover). Z. Immunitaetsforsch. Allerg. Klin. Immunol., 134: 81-90(Nov. 1967). (In German).

The antibody-plaque technique was used to follow the number of hemolysin-producing spleen cells after irradiation with 250 R. The x radiation was given either 48 hr before or 48 hr after intraperitoneal injection of $4 \times 10^8$ sheep red cells. If given 48 hr before injection of antigen, the rise of plaque-producing cells was delayed 2 days and its maximum level was significantly reduced to 20% below that of control animals. The serum hemolysin titer was reduced 25%. When radiation was given 48 hr after antigen, the absolute number of plaque-producing cells a day after irradiation was lowered to one-third in comparison with the number in control animals. The maximum level was delayed one day and the maximum rise was slightly but not significantly reduced. The hemolysin maximum level in the serum was lowered to 65% of the control value. Whether the alteration of antibody synthesis after x irradiation at various times corresponded to the differing radiosensitivity of antibody-forming cells or to damage of the immunogenic function of the macrophages was not ascertained. (BBB)

## Ecology

**45469** RADIOECOLOGY OF $^{65}$Zn IN AN ARM OF THE COLUMBIA RIVER ESTUARY. Renfro, William Charles. Corvallis, Oreg., Oregon State Univ., 1968. 94p.

Thesis.

Levels of $^{65}$Zn in water, sediments, plants, and animals in Alder Slough, a small ecosystem in the Columbia River Estuary, were determined periodically during a one year period. Concentrations of total Zn in organisms were also measured to permit computation of specific activities ($\mu$Ci $^{65}$Zn/g total Zn). Temporal fluctuations in the activities of $^{65}$Zn and the concentrations of total Zn occurred in all components of the ecosystem. Activities of $^{65}$Zn and concentrations of total Zn varied among individual fish from the study area. Pooled estimates of population standard deviations of these values in all samples of two fish species taken during the year amounted to about 20% of their grand means. Usually, individuals with high $^{65}$Zn activities also proved to have high total Zn concentrations, hence specific activities were less variable than either $^{65}$Zn or total Zn. The nuclear reactors at Hanford, Washington, the source of most of the $^{65}$Zn in the Columbia River, were shut down for approximately 45 days during this study. This event presented the opportunity to investigate the response of various components of the ecosystem to reduced $^{65}$Zn input. The rates of $^{65}$Zn specific activity decline in several organisms were measured following reactor shutdown. The time required for specific activity of an organism to be reduced by one-half under the conditions prevailing is termed ecological half-life. The ecological half-life differs from the biological half-life of an organism because: it is defined in terms of specific activity; it reflects the continued addition of radioactivity to the organism from its food web and water. Ecological half-lives vary with the trophic levels of the organisms and with changes in prevailing ecological conditions. (Disser. Abstr.)

**45470** RADIATION DOSES SUSTAINED BY LIZARDS IN A CONTINUOUSLY IRRADIATED NATURAL ENCLOSURE. Turner, Frederick B.; Lannom, Joseph R. Jr. (Univ. of California, Los Angeles). Ecology, 49: 548-51(Late Spring 1968).

Desert lizards occupying a 20-acre experimental facility continuously exposed to gamma radiation sustained tissue doses that were less than the cumulative free-air dose. Vegetation and terrain afforded some shielding, but time spent below ground was the major source of protection. It was estimated that, in the course of a year, tissue doses sustained by Uta stansburiana were from 0.3 to 0.6 of the cumulative free-air dose, and that about 1/3 of the total dose was experienced between June and August. Cnemidophorus tigris spent less time above ground, and sustained annual doses representing only about 0.1 to 0.2 of total incident γ radiation. The dose experience of Crotaphytus wislizeni was intermediate to the other two species. Dose regimes experienced by Uta stansburiana in the experimental area are not acutely lethal. (auth)

**45471** THE INFLUENCE OF CHRONIC GAMMA IRRADIATION ON PRODUCTION AND DECAY OF LITTER AND HUMUS IN AN OAK–PINE FOREST. Woodwell, G. M.; Marples, T. G. (Brookhaven National Lab., Upton, N. Y.). Ecology, 49: 456-65(Late Spring 1968).

The irradiated forest at Brookhaven National Laboratory was used to examine the flux of organic matter through the organic horizon of soil. Production of litter along the gradient of intensity of radiation proved an excellent criterion of radiosensitivity. The standing crop of organic matter in soil was about 6,300 g (dry weight)/$m^2$. Of this about 4,700 g was humus and 1,600 g litter. Annual input of litter averaged 342 g; of roots, about 311 g. The rate of decay of all organic matter in the surface soil was 10 to 12%/year. The litter layer decayed more rapidly at about 16%/year, the humus more slowly at about 8.4%/year. Decay of litter of white oak in the first year on the ground was 58%, that of scarlet oak, 67%. Irradiation at 600 to 700 R/day consistently increased the rate of decay of litter. Studies of the radiosensitivity of the principal species of trees and shrubs showed: a lag of 1 year in the initial effects of irradiation behind the exposures causing them; a regular increase after the first year in total cumulative exposure causing 50% reduction in the production of foliage; and shifts in the relative sensitivities of species with time: the scarlet oak, initially more sensitive than the white oak, recovered in three years to be more resistant than white oak, and the sensitivities of white oak and pitch pine appeared to converge at about 30 years. (auth)

## Genetics and Cytogenetics

*Refer also to abstracts 45531, 45612, and 45726.*

**45472** (NYO–1979-27) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Progress Report, June 1, 1967–May 31, 1968. Green, Earl L. (Jackson Lab., Bar Harbor, Maine). June 30, 1968. Contract AT(30-1)-1979. 18p. Dep. CFSTI.

The effects of high-energy-radiation on the genetic fitness of random bred mouse populations are discussed. Studies on the extent of genetic variation in radiation resistance showed a significant heritability of radiation resistance for almost all definitions of radiation resistance with values as high as 0.50 in the $LD_{50:30}$ and the length of survival under 100 R per day of whole-body X-irradiation. Selection studies on the nature of the genetic variation indicated that variation in radiation resistance was due to at least three loci and probably more; a major separation of the high and low lines in the early generations of selection, followed by a gradual separation for another 15 generations was observed. It was also shown that there was a correlation of means of inbred strains for survival under 100 R per day and the $LD_{50:30}$. This correlation was thought to be through a recovery component of radiation resistance, since the correlation did not hold between fitness traits and survival under much higher doses of irradiation. (B.S.L.)

**45473** (ORO–2909-7) THE NORTHWARD MIGRATION OF CITRUS BY MEANS OF RADIATION-INDUCED MUTATION. Progress Report, October 1, 1967–June 30, 1968. (North Carolina State Univ., Raleigh). July 1968. Contract AT(40-1)-2909. 14p. Dep. CFSTI.

Reported are the selective effects of the winters 1964 to 1965 through 1967 to 1968, reduced by decreasing degrees of shielding called test stages 1 through 4, on three populations of descendents of irradiated Citrus buds and their corresponding non-irradiated controls. The hypothesis being tested was that among mutations induced in the somatic cells of citrus there would be some which affected resistance to cold, that these would be expressed to some degree in vegetative descendents of irradiated buds, and that the degrees of protection provided would discriminate the supposed differences in cold tolerance. It was demonstrated that the discriminating power of the four stages of protection provided was over-ridden by variation from winter to winter within stages. A fifth stage located near the Atlantic coast appeared to provide an alternative to the differences between years in test stage three and between test stages three and four. (auth)

**45474** RADIOINDUCED MUTATIONS IN DERMATOPHYTES. I. MORPHOGENETIC MUTANTS OF MICROSPORON GYPSEUM (BODIN) GUIART AND GRIGORAKI. Hejtmanek, M.; Hejtmankova-Uhrova, Nora; Kunert, J.; Lenhart, K.; Vicikova, Libuse (Palacky Univ., Olomouc, Czech.). Mycopathol. Mycol. Appl., 33: 321-37(Dec. 13, 1967). (In German).

The induction, by uv irradiation, of 26 mutants with colony characteristics differing from the parent strain of Microsporon is reported. The $F_1$ and $F_2$ ascospores from crosses between virulent cultures (f. incurvata x f. incurvata; f. incurvata x f. lanogypsea)

of Microsporon gypseum were treated by uv radiation at an intensity of 51.2 mW/cm², the $LD_{99}$. Morphological mutants were isolated by methods which were described. The persistence of morphological changes was proved by 20 transfers (interval of transfer: three or four weeks). According to the characteristic features of the colony, the mutants were classified into three groups: fluffy cultures, grainy cultures, and interchanging cultures. Data were presented on the appearance of the mutants, their growth rate on agar medium compatibility, pathogenicity, sensitivity to griseofulvin, growth on hair, and the manner of hair destruction. (BBB)

**45475** CHROMOSOME ABERRATIONS IN RADIUM THERAPY PERSONNEL. Bauchinger, M.; Hug, O. (Institut fuer Biologie der Gesellschaft fuer Strahlenforschung, Munich. Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 97-103(July 1968). (In German).

A significant increase in chromosome aberrations was observed in the lymphocytes from peripheral blood of 34 radiographers who had been subjected to between 0.1 and 92 R over a period of 0.1 to 13 years. On average 4.6% of cells showed such defects. There were cells with chromosomal breaks as well as altered chromosome structure. Breakage rate was 0.056 per cell, four times as high as among controls. The number of aneuploid cells was also increased. Chromosome examination in eight doctors with a personal dose less than 5 R showed no difference, as compared with unirradiated controls. (auth)

**45476** TRYPTAMINE FORMATION BY MUTANTS OF CLAVICEPS PURPUREA. Sheu, C. W. (Univ. of California, Berkeley); Paul, A. G. Lloydia, 31: 9-16(Mar. 1968).

The isolation and properties of radioinduced C. purpurea mutants capable of producing high levels of van Urk positive compounds in submerged cultures are reported. Thin-layer chromatographic (TLC) analysis of culture extracts revealed that tryptamine was the principal compound produced. The mutagens were uv light produced by a General Electric type A germicidal lamp and γ rays produced from a 10,000-Ci $^{60}$Co source that gave a 633 Krad/hr dose rate. Filtered conidial suspensions (about $10^6$ conidia per ml) of 2 strains (PRL-1578-12 and H-186-10) were treated with the mutagens. The survival curves of conidia at various doses of uv light and γ irradiation are shown. Radiation doses permitting about 1% survival were selected for application. This level of survival was obtained by exposing conidia to uv light for 120 sec from a distance of 35 cm or to 125 Krad of γ rays. A total of 406 monoconidial isolates, prepared from irradiated conidial suspensions, was grown in submerged culture and the culture media assayed for contents of van Urk positive compounds. Most of the isolates failed to produce detectable amounts of such compounds during two weeks of growth; however, a few isolates produced significantly higher yields of such compounds than the wild type strains. Both wild type parents and five superior mutants $M_1$ (an isolate from uv-irradiated PRL-1578-12) and $M_2$, $M_3$, $M_4$, and $M_5$ (isolates from γ-irradiated H-186-10) were subjected to TLC analysis for the nature of van Urk-positive compounds. $M_1$ and $M_5$ were subjected to a second irradiation dose which allowed a survival level of 10%. This level was achieved by the treatment of both $M_1$ and $M_5$ with uv light for 90 sec and for γ irradiation, 75 Krad and 50 Krad, respectively. A total of 325 isolates was examined, and isolates with marked increase in productivity over parent strains were obtained. (BBB)

**45477** MUTATION BREEDING OF DAHLIA VARIABILIS. Broertjes, C. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen, Netherlands); Ballego, J. M. Euphytica, 16: 171-6(1967).

Tubers of garden dahlia cultivers were irradiated with various doses of x rays. The optimal dose ranged from 2 to 3 Krad, considering the production of rooted cuttings, speed of rooting, subsequent development of the young plants as well as mutation frequency. At doses from 1 to 3 Krad the production of shoots, expressed as the number of rooted cuttings per five tubers, varied little with dose though it decreased sharply after 4 Krad. However, the number of normally growing and rapidly rooting shoots decreased more sharply with increasing dose. Plants from slowly formed shoots generally showed poor growth. Many mutations for flower color and shape were observed in three irradiated varieties. Fairly rapid results (the tubers were irradiated only 3 yr ago) were obtained by the propagation method used in dahlia. This method of taking cuttings from the crown of the irradiated tubers often resulted in mutated tissue taking part in the formation of new tubers, thus enabling the mutated character to be transmitted to the next vegetative generation. (BBB)

**45478** RADIATION BREEDING EXPERIMENT WITH PEANUTS. Gregory, W. C. (ed.) (North Carolina State Univ., Raleigh). Contracts AT(40-1)-265; AT(40-1)-1747. Radiat. Bot., 81-147(Apr. 1968).

A review is presented of published and unpublished work in this field. An attempt is made to bring out the underlying physical and biological hypotheses upon which the experimental work was conceived and to report the results of the individual experiments which either supported or questioned the premises upon which the experiment was based. It was shown that radiation induced mutations of very small effect may be exposed in the genomes from which the large and therefore detrimental changes have been expunged, and that these mutations increase in frequency as an exponential function of their diminishing effect. This phenomenon is related to Fisher's adaptation sphere upon which he based his calculation to show that as random changes of n directions become exceedingly small the probability of effecting an improvement equals exactly one-half at the limit. Examples are reported of the Mendelian inheritance of the macro-mutations induced, the graded expressivity of the macro-mutant as a function of cryptic genetic changes in genomic backgrounds, the correlation of the fruit yield with diminishing expressivity of the macro-mutants themselves, and the quantitative genetic expectations of normal sibs and their normal segregates from hybrids among the macro-mutants. Also shown are the heterotic effects in hybrids between superior selections from a single population of irradiated peanuts and the relative independence of the induced mutation in irradiated $F_1$ hybrids and that arising from hybridity. The probability of the additive nature of the quantitative variation induced was indicated through diallel analysis of hybrids among mutants and by an estimation of covariances among relatives in generations directly following irradiation. (UK)

**45479** INFLUENCE OF GENOTYPE ON THE FREQUENCY OF RADIATION-INDUCED ANEUPLOIDY IN OOGENESIS OF DROSOPHILA MELANOGASTER. II. HETEROZYGOUS INVERSIONS IN THE X AND THE II CHROMOSOMES. Glotov, N. V.; Semenova, V. A. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 4: No. 2, 124-8(Feb. 1968). (In Russian).

In progeny of $y/y\ sc^{SI}$ in 49 v $sc^8$; $Cy/_+$females spontaneous frequency of exceptional XXY-females of 2.0 percent and that of exceptional X0-males of 1.8 percent were found. Dose-response curves were obtained for the frequencies of XXY-females and X0-males following the female-parent irradiation with $^{60}$Co γ rays at doses of 1, 2, 3, 4 and 5 kr the comparison of the curves (control values subtracted) with corresponding doseresponse curves obtained for yellow (telocentric X) and $X^c$, y v (ring X-chromosomes) females, the latter two differing, also, from the first one by (one to two orders of magnitude) lower frequencies of spontaneous aneuploidy, revealed the independence of the frequency of radiation-induced aneuploidy of the anomalous chromosome conjugation, and of the high frequency of spontaneous aneuploidy characteristic to interchromosoma effect. A complex segregation observed in the experiment is analysed in detail. (auth)

**45480** KINETICS OF THE LETHAL AND MUTAGENIC EFFECT OF THE UV-IRRADIATION ON ESCHERICHIA COLI K-12 Hfr C AND ON ITS SENSITIVE MUTANT. Skavronskaya, A. G.; Zavil'gel'skii, G. B.; Likhoded, L. Ya. (Gamaleya Inst. of Epidemiology and Microbiology, Moscow. Inst. of Molecular Biology, Moscow). Genetika, 4: No. 2, 90-6(Feb. 1968). (In Russian).

The properties of a slime-producing mutant $Lmuc^+$ of Escherichia coli K-12 Hfr C forming long filaments after the uv-irradiation were studied. It is shown that this mutant has a relatively high sensitivity to uv-irradiation. The capacity to repair the uv-irradiated phage λ is completely retained. Acriflavine was observed to increase to the same extent the death-rate of the uv-irradiated cultures of the wild type and of the mutant strain. It is concluded that the mutation of the lon gene leads to the decrease of the capacity to reactivate the uv-irradiated bacterial DNA. This effect can be associated either with a partial inhibition of the hcr-system or with the loss of the special system determined by the lon-gene. (auth)

**45481** ON THE PROBLEM OF APPLICABILITY OF THE METHOD OF POLLEN IRRADIATION TO THE HYBRIDIZATION OF SOME FRUIT TREES. Yakovlev, S. P.; Ostapenko, V. I. (Michurin Central Genetic Lab., Michurinsk, USSR). Genetika, 4: No. 2, 62-74(Feb. 1968). (In Russian).

Pollen of fruit trees was irradiated with γ, uv, and x rays preceding hybridization experiments. The productivity of hybrid pears and members of the subfamily Pomoideae was increased following uv irradiation of pollen. Sixty minutes of uv irradiation of pollen of pears and members of the subfamily Pomoideae proved to be the optimum exposure time. Productivity of hybrids of pears and pip fruits was considerably increased by γ irradiation of pollen at a dose rate of 13.25 R/min. Optimal doses of γ irradiation for pears were 500 and 900 R. X radiation resulted in a considerable increase of the productivity of hybrids. It is pointed out that op-

timal doses of radiation vary with different species and varieties of fruits. (H.L.W.)

**45482** RADIOSENSITIVITY STUDIES WITH WOODY PLANTS. I. ACUTE GAMMA IRRADIATION SURVIVAL DATA FOR 28 SPECIES AND PREDICTIONS FOR 190 SPECIES. Sparrow, A. H.; Rogers, Anne F.; Schwemmer, Susan S. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 8: 149-86(Apr. 1968). (BNL-12116).

Survival curves were determined for 12 species of woody angiosperms and 16 gymnosperms given 16-hr $\gamma$-irradiations during the early period of spring growth. The plants were scored approximately one year after irradiation and annually thereafter for up to 6 years. Since second-year scoring was found to be a reasonable approximation of ultimate survival, second-year survival data were used throughout. $LD_{10}S$, $LD_{50}S$ and $LD_{90}S$ were determined from survival curves fitted by probit approximation; $LD_{100}S$ were actual values (first exposure which killed all plants). $LD_{50}S$ in the gymnosperm species ranged from 460 to 1203 (average 826 ± 54 R) and in the angiosperms from 477 to 17,500 R (with 8 of the 12 species between about 3000 and 8000 R). The relationship previously found between interphase chromosome volume (ICV) and radiosensitivity for other end points was confirmed for the above end points (the larger the ICV, the greater the sensitivity). The regressions obtained by plotting $LD_{10}S$, $LD_{50}S$, $LD_{90}S$, and $LD_{100}S$ against ICVs had similar slopes (average −0.73). Predicted radiosensitivities of species not irradiated can be obtained from these regressions if the ICV is known. Within a species, nuclei of actively growing woody plants average 1.65 times larger than those of dormant plants, and nuclei of terminal buds, 1.25 times those of lateral buds. These differences are reflected in the expected differences in radiosensitivities. ICV's were determined for 190 additional unirradiated species of gymnosperms and woody angiosperms, mainly for the purpose of predicting $LD_{50}S$ and other end points. A wide range of ICVs was found, with gymnosperms tending to have large ICVs, and most angiosperms relatively small ICVs, with little overlap between the two groups. The rank order of ICVs and predicted $LD_{50}S$ is given for 45 plant families (mostly based on a small number of species per family). About 50 per cent of the 120 gymnosperms studied had predicted $LD_{50}S$ of 1 kR or less. Only five species had $LD_{50}S$ above 2 kR and none of these is of major economic value. The predicted $LD_{50}S$ for 95 angiosperm species tend to be much higher, with over 80 per cent between 2 and 8 kR, only 11 species at 2 kR or less and only 4 above 8 kR. Since exposure times much shorter than the 0.16-hr periods used (but common in mammalian radiation studies) would lower the plant $LD_{50}S$ appreciably, it appears that the radiosensitivity of a high percentage of acutely irradiated gymnosperm species would be in the same general range as that of mammals. These predictions can be used as a rough estimate of the exposures required to produce a specified amount of radiation-induced injury in the planning of future experiments or in rough predictions of the consequences of the $\gamma$-component of fallout radiation. The usefulness of such predictions and some of the factors limiting their accuracy are discussed. (auth)

**45483** IS AGE-DEPENDENT GENETIC DAMAGE IN SEEDS CAUSED BY FREE RADICALS? Conger, Alan D. (Temple Univ., Philadelphia); Randolph, M. L. Radiat. Bot., 8: 193-6(Apr. 1968). (ORNL-P-3503).

In dry seeds of several kinds stored for up to 48 yr, no significant changes in electron spin resonance patterns vs. age were found, although four classes of signals were observed. This result is counter to some notions of how genetic damage from aging of seeds might arise from free radical reactions, and differs from ESR observations related to radiation-induced damage. (auth) (UK)

**45484** THE RBE OF HEAVY PARTICLES FROM THE REACTION $^{10}B(n,\alpha)^7Li$ FOR CHROMOSOME ABERRATIONS IN NIGELLA DAMASCENA L. Moutschen, Jean; Moutschen-Dahmen, Madeleine; Woodley, Robert; Archambeau, John (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 34: 488-500(1968).

Nigella damascena seeds, enriched or not by $^{10}B$, were irradiated with thermal neutrons. In both cases the effects on chromosomes were investigated during the first mitotic cycle after the onset of germination. All the aberrations were found to be of the chromosome type—that is, induced during the presynthetic $G_1$ period. By comparison with the effects of $^{137}Cs$ $\gamma$ rays on the same material, RBE values could be calculated for several kinds of aberrations. RBE's were found to be generally high. These findings are discussed and compared with other results reported in the literature. (auth)

**45485** AN EFFECT OF VARIOUS DOSES OF GAMMA RAYS UPON THE INCREASE IN THE RANGE OF VARIATION IN FEATURES OF BARLEY OF BROWARNY PZHR VARIETY. PART II. CHARACTERISTICS OF MUTANTS SELECTED FROM THE POPULATION OF IRRADIATED PLANTS. Pala, Janusz (Zaklad Biologii i Fizjologii Rozwoju Roslin, Radzikow, Poland). Hodowla Rosl., Aklim. Nasien., 9: 493-529(1965). (In Polish).

Ionizing radiation was used to increase the variation of features in brewer's barley of the PZHR variety. Seed with 11.7% water content was irradiated with doses of 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 KR of $\gamma$ rays. An analysis of four plant generations revealed some forms that might be of significance in the improvement of this barley variety. Most numerous mutants obtained were erectoides types, that were characterized by their considerably shorter and more rigid stalks, when compared with the parent variety, and a more compact ear. All of these forms were obtained after a dose of 6 KR. Other forms were obtained under the influence of $\gamma$ radiation, among which, as the more valuable ones were three lines characterized by a lower content of protein in the seed, on an average by 2%, when compared with plants of the initial variety; two lines of plants with considerably increased resistance against fungi of the Perisporiales group; five lines of plants with earlier ear formation; and three lines of plants with a weight of 1000 grains exceeding 50.0 g. Genetic homeostasis of the plant population was not altered by the $\gamma$-ray doses used. This was indicated by an analysis of more than 52,000 plants on the basis of height, general and productive propagation, length of main ear, weight of 1000 grains, and protein content of the seed. It was found, however, that certain doses resulted in an increase in number of individuals characterized by extreme values of these features. An increase in variations of modifying characters was revealed primarily in an increase in the number of plants with fertile lateral ears within the main ear and those with branched ears. 117 references. (BBB)

**45486** CHROMATID ABERRATIONS RESULTING FROM $^3H$-THYMIDINE INCORPORATION INTO EARLY AND LATE S PERIODS IN HUMAN FIBROBLASTS. Ockey, C. H. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 13: 479-84(1967).

Chromatid aberrations were induced by $^3H$-thymidine incorporated in early and late S periods of human XY, XXY, and XX cells. At similar total $^3H$-disintegrations, late S cells were four times (XY) or seven times (XXY) more sensitive than early S cells. This difference is partly attributable to dose-rate differences between samples; early S samples receive irradiation at half the dose-rate of late S samples, and localization differences of the $^3H$-thymidine in cells labeled at the two stages. In late S, label is concentrated over certain chromosomes, whereas in early S it is more evenly distributed. Localization produces an intranuclear dose-rate effect demonstrated by the concentration of aberrations to late-labelling chromosomes, particularly the late X. Any attempt at comparing stage sensitivity must be carried out at an intrachromosomal level. (auth)

**45487** GENETIC DISTRIBUTION OF TEMPERATURE-SENSITIVE MUTANTS OF ESCHERICHIA COLI. Asato, Yukio; Folsome, Clair E. (Univ. of Hawaii, Honolulu). Rev. Latinoamer. Microbiol. Parasitol., 9: 43-6(Apr.-Dec. 1967).

Ultraviolet irradiation led to the isolation of heat-sensitive metabolite irreparable (hsmi) mutants that were obtained in relatively high frequency (0.5%). The strains $F^-$ P678 (lambda)$^-$ and Hfr C of E. coli K-12 were utilized so that conjugation could be employed for mapping experiments. The hsmi mutants of $F^-$ strains were isolated by uv irradiation of log phase cultures. The irradiated cells from which 1 to $3 \times 10^{-3}$ survived were inoculated on nutrient agar plates which were then incubated for about 14 hr at 30°C. Nonmutants formed large colonies while potential hsmi mutants attained an intermediate colony size. Of 7922 colonies scanned in two separate experiments, 36 hsmi mutants were recovered. A frequency of $4.5 \times 10^{-3}$, indicated that hsmi mutant factors were common. The frequency of occurrence of hsmi mutants was calculated to be 25 to 30% of the hs metabolite reparable ones, suggesting that hsmi factors were common and 25 to 30% of the functional genome of E. coli was constituted of hsmi mutant factors. For the four hsmi mutants mapped, a random distribution of hsmi loci was obtained. (BBB)

**45488** EFFECT OF SPACE FLIGHT ENVIRONMENTS ON SEEDS OF HIGHER PLANTS FLOWN ON BOARD COSMOS-110. Delone, N. L.; Morozova, E. M.; Antipov, V. V.; Parfenov, G. P.; Trusova, A. S.; Ukstina, Z. I. Izv. Akad. Nauk SSSR, Ser. Biol., No. 1, 126-9(Jan.-Feb. 1968). (In Russian).

Air-dried seeds of some higher plants were placed in the Cosmos-110 cabin. After recovery the seeds were grown together with controls and physiological and cytological studies were undertaken. The test seeds exhibited physiological changes during their germination and disturbances in their hereditary structures. (auth)

**45489** APPLICATION OF THE BIOLOGICAL EFFECTS OF IONIZING RADIATION TO THE IMPROVEMENT OF PLANT

PRODUCTION. Pereau-Leroy, Pierre; Silvy, Andre (CEA, Cadarache, France). Ind. At., 12: No. 5-6, 41-9(1968). (In French).

The modifications of a physico-chemical and genetic nature produced in plants by γ or x rays may well contribute to the improvement of vegetable production. Whereas the inhibiting of growth is finding its first industrial application in the preservation of potatoes and onions, there has been no confirmation of increases in output when grains and tubers are given weak doses of irradiation. Certain new varieties may be brought into existence by mutation or by dechimerization, depending on the histo-genetic composition of the plants and on their reproductive patterns. It is pointed out that more thorough study will still be necessary if we are to achieve a greater effectiveness in irradiation techniques. (auth)

**45490** RELEVANCE OF INTRACELLULAR DAMAGE TO EFFECTS IN THE COMPLEX ORGANISM. Mole, R. H. (Medical Research Council, Harwell, Eng.). Proc. Roy. Soc. Edinburgh, Sect. B, 70: 152-62(1968).

If the size of the intracellular pool of gene products determines the time interval between genetic damage at the time of radiation exposure and the appearance of the irreversible changes of cell death, then each class of cell would be expected to have its own characteristic mode of behavior and the difference between interphase death and death at or following mitosis would have no particular significance. The implications for radiation carcinogenesis of chromosomal aberrations in circulating blood lymphocytes may be that they indicate persistent damage to the process of immunological surveillance that usually destroys most incipient neoplastic cells before they have time to produce a recognizable neoplasm. Much of what occurs in the irradiated organism can be accounted for simply as the consequence of reduction in cell numbers. The behavior of mammalian cells in culture in vitro provides a guide to the behavior of stem cells in the mammal as long as it is recognized that cells in culture in vitro are in cell cycle whereas most stem cells in vivo are not. This results in a difference in the kinetics of recovery, one consequence being that the response of tissues in the complex organism may change during protracted exposures. (BBB)

**45491** LATENT GENETIC EFFECTS OF X IRRADIATION ON SEEDS OF MAIZE. INFLUENCE OF STORAGE OF SEEDS BEFORE IRRADIATION AND OF THEIR CONTENT OF WATER. Van de Walle, C. (Institut de Botanique, Liege). Bull. Soc. Roy. Sci. Liege, 37: 111-23(1968). (In French).

X irradiation of maize seeds produced white or yellow-green streaks on the leaves. The number of streaks on the second leaf was taken as a measure of the genetic damage. This damage was markedly increased when the seeds were stored in dry state for several days after irradiation. The part of the damage due to storage was called delayed effect; the part obtained without storage was called immediate effect. The number of streaks was affected by the water content of the seeds. Delayed effect and immediate effect were not affected in a similar manner. The delayed effect was practically suppressed when the seeds contained more than 7% water; it increased exponentially when the water content was lowered. The immediate effect was also increased when the water content was lowered but it was not completely abolished even when the water content was increased to 11%. (auth)

**45492** REPRODUCTIVE FITNESS OF DESCENDANTS OF MICE EXPOSED TO SPERMATOGONIAL IRRADIATION. Green, Earl L. (Jackson Lab., Bar Harbor, Maine). Radiat. Res., 35: 263-81(1968).

Nonirradiated descendants of irradiated and nonirradiated random-bred populations of mice were compared with respect to their lifetime reproductive performances, including percentages of fertile matings, mean numbers of litters, mean litter sizes, percentages of survival between birth and weaning, mean total numbers of progeny, and mean numbers of days of reproductive life. The populations were of two kinds, called inbred and hybrid to denote their origins. The accumulated genetic exposures to x irradiation varied from 0 R in the control populations to 5400 R in one of the exposed populations. Spermatogonia were the only cell stages tested for genetic effects on reproductive fitness. The results indicated that there were no differences in reproductive fitness between the matings of nonirradiated descendants of the control and various irradiated populations. (auth)

**45493** SALIVARY GLAND ANALYSIS AND LOCALIZATION OF SECOND CHROMOSOME RECESSIVE LETHALS OBTAINED AFTER IRRADIATION OF SPERMATOGONIA AND SPERMATOZOA IN DROSOPHILA MELANOGASTER. Ytterborn, Karl H. (Univ. of Stockholm). Hereditas, 59: 49-62(1968).

Three different series of lethal chromosomes were analyzed cytologically and in recombination tests. Series A consisted of lethal chromosomes obtained after x irradiation (900 R) of spermatozoa in adult males. Series L I and L VI were obtained after matings 0 to 3 days and 15 to 18 days respectively after eclosion of males treated as 17-hr-old larvae, that is, when no other germ cells than spermatogonia were present, with the same dose. Five lethals were found to be associated with aberrations out of 26 chromosomes analyzed in series A. No aberrations were found among 36 tested chromosomes in series L I or among 34 tested in L VI. The chromosomes containing no aberrations were by recombination tests classified as containing 1 or 2 lethals. Two out of 21 chromosomes were considered to be carriers of 2 lethals in series A and 1 and 2 respectively in series L I and L VI. The distributions of the lethal mutations along the chromosome were similar in the 3 series. (BBB)

**45494** RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN LEUKOCYTES IN VITRO: TIME-EFFECT DEPENDENCE. Suskov, I. I. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 4: No. 6, 124-7(June 1968). (In Russian).

The leukocytes of human blood were x-rayed in vitro at $G_1$-stage with 100, 150, 200 R and fixed after 52 to 54, 60, 66, 72 hr of culturing at the first mitosis. In one of 150 R x-rayed cultures the mitosis of cells was initiated by means of PHA in 10 hr after irradiation. The frequency of metaphase chromosome aberrations was studied. The frequency of aberrations is invariable at different times of cell fixation at the first mitosis. The delay of mitosis initiation did not change aberration rates. The frequency of x-ray induced aberrations was 0.0026 chromosome type breaks per cell per two per cell/R or 0.000056 breaks per chromosome per two chromosomes. (auth)

**45495** STUDY OF THE RADIOSENSITIVITY OF CHROMOSOMES IN NORMAL PERSONS AND IN CASES OF DOWN'S DISEASE. Chudina, A. P. (Inst. of Experimental and Clinical Oncology, Moscow). Genetika, 4: No. 6, 99-110(June 1968). (In Russian).

The frequency of leukosis is known to be above the normal level among persons with congenital chromosomal abnormalities, in particular, in cases of Down's disease. This investigation was to find out whether this phenomenon is associated with a higher sensitivity of chromosomes in aneuploid cells to the action of mutagenic factors. Thus, the radiosensitivity of chromosomes in the cells of healthy persons and of those affected by Down's disease was compared. The cultures of peripheral blood taken from six children affected by Down's disease, five healthy children and several healthy adults were irradiated at doses of 10, 20, and 40 R five hours before fixation. The frequency of the numeric and structural chromosomal anomalies was determined by examination of 3624 metaphase plates. The groups of persons studied did not differ from one another in the proportion of aneuploid cells. Most structural chromosome aberrations were of the chromatid type both in the irradiated and in the control material. The spontaneous frequency of aberrations varied from experiment to experiment, but these differences were probably associated with the variations in the conditions of culture growing rather than with the specific individual characteristics of the patients and healthy persons studied. With respect to the number of chromosome breaks per cell per 1R the chromosomes of the children affected by Down's disease were more radiosensitive than those of the normal children, but did not differ from the chromosomes of the normal adults. The chromosomes of healthy children proved to be less radiosensitive than those of the healthy adults. The distribution of the chromosome damages among the chromosome groups was random in healthy persons, both children and adults. A nonrandom distribution of damages was observed in trisomic cells. The relative frequency of freaks in the groups D, F, and G was higher in cases of Down's disease than in normal individuals. The results are discussed in connection with some problems concerning the role of chromosome damages in the malignization of cells. (auth)

**45496** MUTAGENESIS IN THE COURSE OF THE GENETIC TRANSFORMATION OF BACILLUS SUBTILIS AND THE EFFECT OF THE X IRRADIATION OF THE TRANSFORMING DNA. Chernik, T. P.; Kriviskii, A. S. (Inst. of Molecular Biology, Moscow). Genetika, 4: No. 6, 75(June 1968). (In Russian).

In a number of experiments on the transformation of a tryptophane-synthetase-deficient strain T3 of Bacillus subtilis (tryp$^-$) by means of the prototrophic DNA, that had not been subjected to the action of any mutagenic agent, an unusually high frequency (up to 0.26% versus about 0.02% known from the literature) of fluorescent (F) mutants ind$^-$ (accumulating anthranylic acid and its derivatives) was observed among the resulting tryp$^+$ transformants. It is shown that F mutants did not pre-exist, either in the recipient culture as mutant ind$^-$

cells, or in the donor DNA, as mutant molecules, but initiated in consequence of the recombination in the course of the transformation. The irradiation of the prototrophic DNA with x-rays did not induce any mutagenesis involving the ind⁻ marker studied, but caused only the inactivation of the transforming capacity (of the tryp⁺ marker). In those experiments in which there was a spontaneous background of high frequency of F-mutations the irradiation of the donor DNA decreased the frequency of F-mutants. The possible mechanisms of the initiation of F-mutations in the course of the transformation and the causes of the decrease of their frequency as the result of the roentgen irradiation are discussed. (auth)

**45497** COMPARATIVE STUDY OF THE MUTAGENIC EFFECT OF THE UV-RADIATION ON THE EXTRACELLULAR PHASE φX174 AND ON ITS INFECTIOUS DNA. Belykh, R. A.; Kriviskii, A. S.; Chernik, T. P. (Inst. of Molecular Biology, Moscow). Genetika, 4: No. 6, 62-70(June 1968). (In Russian).

The purified phage φX174 and the infectious DNA isolated from this phage were subjected to uv irradiation simultaneously and under identical conditions. The phage was observed to be more sensitive to the uv rays than its infectious DNA. The temperature-sensitive mutations, the spontaneous frequency of which in the phage is the same as in its infectious DNA, were induced by the uv irradiation both in the phage and in the DNA, the frequency resulting from the irradiation of the intact phage being eight times as high as the spontaneous frequency, while in the irradiated DNA the increase was four-fold. The temperature-sensitive mutants in the intact phage are similar in character to those in the DNA. The most frequent were the leaky mutants, whose viability, though being retained at +43°C, is much poorer at this temperature than at +37°C. The causes of the differences between the intact phage and its DNA in the level of mutagenesis and in the sensitivity to uv irradiation are discussed. (auth)

**45498** INFLUENCE OF THE GENOTYPE ON THE FREQUENCY OF RADIATION-INDUCED ANEUPLOIDY IN THE OOGENESIS OF DROSOPHILA MELANOGASTER. IV. SECONDARY NON-DISJUNCTION OF X-CHROMOSOMES. Glotov, N. V. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 4: No. 6, 55-61(June 1968). (In Russian).

Dose-response curves are presented (within the range from 1 to 5 kr of $^{60}$Co γ rays) for XXY-females of two genotypes. In the progeny of XXY; $ca^{nd}$/ + females spontaneous frequency of exceptional flies was 3.9 per cent for females and 3.4 per cent for males. Their frequency in the progeny of y/y $sc^{51}$ In 49 × $sc^{8}$/Y females was 35.0 and 37.1 per cent respectively. The dose-response curves for the frequencies of exceptional progeny in XXY; $ca^{nd}$/ + did not differ from the earlier obtained curves for XX-females. The curves obtained in the irradiation experiments with y/y $sc^{51}$ In 49 v $sc^{8}$/Y exhibited an unusual slope: with the increasing dose the frequency of exceptional flies decreased. It is assumed that the difference observed between the dose-response curves are associated with the differences in the spontaneous frequencies of chromosome non-disjunction, owing to the two oppositely directed processes induced by irradiation, viz. the one prohibiting the non-disjunction (apparently chromosome aberrations) and the other one inducing it. (auth)

**45499** INVESTIGATIONS OF EXPERIMENTAL MUTAGENESIS IN ARBOREOUS PLANTS. Privalov, G. F. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika, 4: No. 6, 144-57(June 1968). (In Russian).

The survey of literature on the experimental induction of somatic mutations in arboreous species presented in this paper shows that, as a rule, the treatment with mutagenic agents results in the initiation of chimeric plants. The main source of failure in the induction of somatic mutations is the inadequate use of methods for their detection in chimeric plants. The main methods of detection of somatic mutations are the cloning of the vegetative buds, of the lateral meristem, and the recombination of somatic tissues in chimeric plants induced by mutagens. Most somatic mutations are detected at the base of shoots growing from buds or seeds treated with mutagens. The main types of genetic effects of treatments with mutagens in somatic and generative cells are described, as well as the behavior of mutant cells in somatic tissues in the course of ontogenesis and the main types of mutations occurring in arboreous plants. Information on the optimal doses for the irradiation of seeds, cuttings, and pollen of certain species, data on the frequency of mutations, both somatic and gametic, induced by mutagens, and the list of mutations induced in different countries in 13 species of forest trees, fruit trees and ornamental arboreous plants is presented. (auth)

**45500** CHROMOSOME ABERRATIONS AND THEIR PERIODIC CHANGE AFTER RADIUM–X RAY THERAPY OF GYNOCOLOGICAL TUMORS. Bauchinger, Manfred (Institut fuer Biologie, Nuremberg. Univ., Munich). Strahlentherapie, 135: 553-64 (May 1968). (In German).

In 92 female patients 129 chromosome studies were made after combined irradiation with x rays and radium. Immediately after the irradiation, 22% of the cells studied were found to have structural defects. The rate of chromosome breaks in all cells examined was 0.47, this is twenty times the observed normal value. Three to four years later, the observed number of S cells with structural defects was only one third the original value. The number of breaks decayed in the same way. A proposed classification system is discussed in view of the behavior of the aberrations with time. (auth)

**45501** MUTATIONS IN POTATOES INDUCED BY GAMMA IRRADIATION. Roer, Lars (Farm Corps Inst., Vollebekk, Norway). Euphytica, 16: 283-92(1967).

The irradiations were performed in a $^{60}$Co γ field on uncut, unsprouted, or slightly sprouted tubers at doses ranging from 2000 to 8000 R. In one instance a dose of 16,000 R was applied. As expected, all tubers irradiated with 16,000 R failed to sprout. Only a few tubers exposed to 8000 R sprouted. Although all these $M_1$ plants were abnormal, no mutations were detected in the following tuber generations. The best results were obtained with 3200 R; all mutants described occurred among samples exposed to this dose. Most of the aberrants recognized were color mutations or leaf mutations. All these aberrants were inferior to the original clones when tested in yield trials. In the variety, Pimpernel, a mutant occurred with definitely shorter stolons than the original clone, but this character was correlated with a tendency of the tubers to crack and the clone was not released for commercial use. The possibilities of using artificial induction of mutations in potato breeding are discussed. (BBB)

**45502** RADIATION INTENSITY AND CHROMOSOMAL ABERRATIONS FREQUENCY IN POST-RADIATION PERIOD. Filev, K. (Inst. of Genetics and Plant Breeding, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 159-62(1968).

The quantitative dependence of chromosomal aberrations on the dose-rate and on the duration of storage of irradiated barley seeds was investigated. Seeds (11.5% moisture) were γ-irradiated ($^{60}$Co) at 1.5 and 18 kR doses at dose rates of 16, 65, 115, and 253 R/min. The irradiated seeds were placed under germination conditions after storage times of 1, 15, 30 and 60 days. The percentage of root tip cells with chromosomal bridges and fragments were determined. It was concluded that the higher the dose-rate within the limits of the same dose, the higher the percentage of cells with chromosome aberrations; with increase in storage time there was a linear increase in the percentage of chromosome aberrations; the initial postradiation process in seeds determined the postradiation effect; and the postradiation effect was much more pronounced for a high dose at all dose-rates. (B.S.L.)

# Health Physics and Safety

*Refer also to abstracts 45139, 45143, 45149, 45178, 45190, 45196, 45197, 45260–45262, 45272, 45279, 45283, 45306, 45313, 45357, 45422, 45627, 45653, and 45720.*

**45503** (ANL-Trans–655) STUDY OF THE PENETRATION OF AEROSOLS INTO FILTER BEDS. Parnianpour, Hassan (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from report CEA-R-3347. 52p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 22: 25826. (W.H.K.)

**45504** (BNWL-SA–1937) [EMERGENCY EXPOSURE CONSIDERATIONS FOR RESCUE AND MEDICAL PERSONNEL]. [Newton, C. E. Jr.] (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 2, 1968. Contract AT(45-1)-1830. 18p.

Considerations which enter into decisions as to the extent of risk to take in emergency radiation accidents are discussed. External and internal emergency exposure criteria, protective clothing, devices, and respiratory equipment, and exposure criteria during treatment are considered. (W.H.K.)

**45505** (DP-MS–66-77) ASSESSMENT OF TRITIUM IN MAN. Reinig, William C.; Sanders, S. Marshall Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 17, 1967. Contract AT(07-2)-1. 16p. (CONF-670521–12). Dep. CFSTI.

From Symposium on Diagnosis and Treatment of Deposited Radionuclides, Richland, Wash.

A study of tritium excretion after an intake of HTO showed an excretion pattern with 3 exponentials during a 415-day period. The intake occurred when an estimated 45.7 mCi was assimilated by an employee in a process area; the exact cause of the intake was believed to be inhalation. Results of 88 urinalyses are presented in tabular form; the calculated amount of tritium in urine using a mathematical model that is described and discussed are included. The usual practice of estimating absorbed dose from the first exponent of the excretion curve resulted in a good approximation of the dose from body-water tritium. In this case, the dose contributed by organically bound tritium was less than that contributed by body-water tritium; the dose to an individual organ was assumed to be between these two values. (B.S.L.)

**45506** (EUR-3290f-e, pp 39-50) SOME PROBLEMS ON THE BIOLOGICAL USES OF TRITIATED THYMIDINE. Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester (England). Paterson Labs.).

Some of the problems encountered in the use of tritium-labeled thymidine in cell studies are discussed. Among the problems discussed are those inherent to the use of tritium, those inherent to the labeling techniques in general, and those inherent to the use of pyrimidines, especially thymidine. The effects of beta emission by tritium are discussed in relation to the purely intercellular scope of the emissions and the problem of transmutation. Regarding the former, although the range of the beta particles is only 1μ, the total dose within that sphere is about 170 rads. This may relate to the low incidence of the latter. The proximity of a DNA molecule determines the extent to which the effects of transmutation will be observed. Other problems discussed relate to factors affecting the interpretation of tracer studies more than problems inherent to technique. These include: the re-utilization of thymidine, to what extent does it affect the so-called dilution curves on which population growth studies are often based; the DNA-turnover rate, to what extent does it occur and how does it affect auto radiographs and grain counting; the pool dilution problem and the pool effect, where high specific activity compounds are affected by pool dilution while low specific activity compounds overflood the endogenous pools; the decomposition of thymidine in the medium, found to be a significant factor, and related more or less to the amount of granulocytes in the culture medium; the question of feedback control of thymidine uptake, which relates to the problem of DNA synthesis where it is not so much suppressed by irradiation, but rather the rate of transport of thymidine into the cell is affected; and finally the interpretation of tracer studies of DNA synthesis in cell cycle studies where hot and cold spots appear on the chromosomes, and how these are related to s-phase activities. (E.R.B.)

**45507** (JPRS-45081(Rev.)) RADIOLOGICAL DECONTAMINATION OF CLOTHING. Tomic, Stevo. Translated from Vojnoekon. Pregl., 119-22(Feb. 1968). 6p. CFSTI.

Methods for decontamination of clothing by brushing and shaking and by washing in water are discussed. Also, mobile laundries for decontamination of clothing are described. (W.H.K.)

**45508** (PG-Report-826) RADIOBIOLOGY RESEARCH UNIT, CHAPELCROSS. Annual Report, 1967. Martin, J. H. (United Kingdom Atomic Energy Authority, Annan (Scotland). Production Group). 1968. 7p. Dep. CFSTI. UK 1s. 9d.

Results of research in the areas of neutron dosimetry and radiobiology are presented. Depth doses of recoil protons obtained with a plastic phosphor dosimeter agreed with the independent ion chamber measurements to within 5% for Cyclotron neutrons. During neutron activation analysis of intra-thyroidal iodine in man, the dose delivered to the thyroid gland did not exceed that from comparable techniques of clinical examination. In neutron- or x-irradiated cells of Chara permeability of the cell wall was modified by structural disintegration and selective permeability by certain ions. Changes were also noted in the activity of the ion pumps. A parallel multiple detector was constructed for use in measuring the total apparent ionization cross-section for heavy ions in organic gases. A magnetic analyzer and an electrostatic lens system capable of varying ion energy from 0 to 5 KeV were designed to determine differential elastic scattering cross sections for simple hydrocarbon molecular ions on hydrocarbon neutral molecules. Solid state detection techniques were used to measure stopping power and ranges of alpha particles in ethylene and propylene in the gas, liquid, and solid phases. Variations were observed in the excretion patterns of metabolites of thymine and tryptophan in man following x irradiation. These variations were thought to be attributable to increased DNA synthesis of thymine and tryptophan in gut epithelial cells. Investigations of thymine metabolism in man, rats, rabbits, and mice using $^{14}C$-thymine, revealed the metabolic pathway and its associated enzymes for this pyrimidine. Cultured ascites tumor cells, erythrocytes, and lymphocytes were used to determine the effects of non-lethal doses of radiation on cells. Radiation effects on nucleosidal phosphorylase in erythrocytes appear to be dose-dependent in rats, but not in man, rabbits, or mice. Investigations on the removal of radioisotopes from the body yielded the following conclusions: for strontium; acute treatment with citrate ion affected strontium excretion; citrate ions and stable strontium had a synergistic effect on radiostrontium excretion, late treatment with salicylate improved this effect; and chronic feeding of fluoride or hexametaphosphate had little effect whereas early use of alginates produced significant increases in excretion, for plutonium; acute treatment with citrate ions reduced body burdens, treatment with DTPA in low doses (0.2g/70kg) was as effective as the higher recommended doses, fluoride and hexametaphosphate treatment had little effect on excretion, and protein binding in plasma was a major factor in retention. The effects of alpha particles on mitotic index and cell turnover in alveolar cells following inhalation of $^{239}Pu$ are in progress. (E.R.B.)

**45509** (SZS-7/68) REGULATIONS FOR THE DETERMINATION OF SURFACE CONTAMINATION. Steuer, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Mar. 1968. 35p. (In German). Dep.

Regulations are presented for the performance of decontamination controls in surface contamination. Methods are presented for the determination of the $\alpha$ and $\beta$ surface contamination by direct measurement and by measurement of the wiping materials. In an appendix the statistical measurement error in radiation protection measurements is evaluated. (J.S.R.)

**45510** STANDARDS OF WORKING LOADS FOR PHYSICIANS OF X-RAY DIAGNOSTIC ROOMS. Katsman, A. Ya.; Tikhonov, K. B.; Khristiani, V. I. (Central Scientific-Research Inst. of Roentgen-Radiology, Leningrad). Vestn. Rentgenol. Radiol., No. 6, 75-81(Nov.-Dec. 1967). (In Russian).

All standards should be included into the working time part used for patient examination (with the x-ray tube switched on and off); due protection should be provided for all office personnel from possible radiation injuries. In a correctly organized structure of working time of a roentgenologist, $^2/_3$ of it should be devoted to the examination of patients (200 minutes per shift). Determination of the maximal permissible time of personnel irradiation is of great importance. This time represents a calculation value determined by objective indices: nominal generation voltage, nominal current, the distance between the x-ray tube and the working place, and the value of the maximal permissible radiation dose. The maximal permissible radiation time of dark room workers per shift is 100 min at a nominal voltage of 110 kV (focus-object distance of 1 m and the nominal current of 3 mA; roentgenoscopy); when the nominal current is 30 mA, only 100 min per shift. (auth)

**45511** TRANSFER OF FALLOUT $^{90}Sr$ TO COWS' MILK. Hardy, E. P. Jr.; Rivera, J. (Atomic Energy Commission, New York). J. Dairy Sci., 51: 1210-14(Aug. 1968).

From 1962 through 1966, the monthly $^{90}Sr$ fallout rate, the accumulated deposit, and the concomitant $^{90}Sr$ levels in animal forage and milk were measured in samples collected at the Colorado State University dairy farm in Fort Collins. During the growing period, 42% of the total $^{90}Sr$ deposit was retained on alfalfa hay at the first cutting, 29% at the second cutting, and 23% at the third cutting. The difference between the first cutting and the two following was significant. These deposition coefficients combined with values for the area of forage utilized by the animal can be used to predict the contamination level of alfalfa hay from the measured total deposit. The total intake of $^{90}Sr$ and the amount secreted in milk were measured in several groups of dairy cows. The transfer coefficients of $^{90}Sr$ from diet to milk ranged from 0.05 to 0.09% per liter of milk per day and were in agreement with tracer and field experiments reported by other investigators. By using the appropriate deposition coefficient, forage yield, forage intake, and diet to milk transfer coefficient, the amount of $^{90}Sr$ in milk was calculated from the measured total $^{90}Sr$ deposit over the growing period. The calculated $^{90}Sr$ in milk levels agreed reasonably well with measured values. For example, during the 1963 growing season, a period of relatively high fallout rate, the calculated amount of $^{90}Sr$ in milk was 18 pCi per liter based on a measured deposit of 2.66 nCi $^{90}Sr$ per $m^2$. Milk samples collected during the same period and analyzed for $^{90}Sr$ showed 20 pCi per liter. (auth)

**45512** DOSE-TIME RELATIONSHIP IN THE RADIOTHERAPY OF METASTATIC LUNG CANCER. Kitabatake, Takashi (Niigata Univ., Japan); Kitagawa, Toshio; Okumura, Yutaka. Tohoku J. Exp. Med., 94: 287-91(Mar. 1968).

A model was developed for the evaluation of the dose-time relation in clinical radiotherapy. The case used for the analysis of this relation was that of 24-yr-old female with multiple nodular cancer metastases of the lung from an apparently well-controlled

mandibular squamous-cell carcinoma. Chest x-ray films taken at intervals were used to follow changes in size of the tumor nodules. Over two opposing fields, irradiation was undertaken using a telecobalt unit. For field 1 a 167-R tumor dose was given daily, six times a week, for field 11 a 333-R daily dose three times a week, and for field 111 a 500-R dose daily twice a week. The tumor dose was calculated using axial transverse tomograms. The tumor dose given through each field was the same, that is 1000 R per week and 4000 R total. Each radiation field contained several nodular shadows of metastases, one of which was measured for diameter changes periodically. Radiation effects could be summarized by the formula: $\log R_n/R_0 = (\alpha/t - \beta)T$, where $R_0$ was the tumor size before treatment, $R_n$ was that after irradiation, t the interval of time between fractions, T the over-all time, and $\alpha$ and $\beta$ constants related to the daily dose. (BBB)

**45513** INVESTIGATIONS ON OCCUPATIONAL EXPOSURE TO X RADIATION. Ciurdareanu, S.; Muica, V.; Comsa, S. (Inspectoratul Sanitar de Stat al Regiunii, Cluj). Igiena (Bucharest), 17: 159-67 (Mar. 1968). (In Rumanian).

Results are reported of investigations carried out in 1965 to 1966 on the degree of exposure to radiation of personnel in medical radiologic departments. It was considered that evaluation of the dose by radiometric measurements gave ~25% higher values than photographic dosimetry and ~10% higher values than the doses measured by means of KID ionization chambers. In an analysis of these discrepancies, the conclusion was reached that photographic dosimetry was the most adequate method for determining occupational exposure in medical radiologic services. Data obtained following analysis of morbidity with temporary occupational disability were also reported. A comparative study was carried out on 180 individuals exposed to x radiation (radiologists and ancillary personnel) and a control group (personnel not exposed to radiations). In the occupationally exposed group there was an increase in the incidence, severity, and average duration of the following diseases: disorders of the blood and hematopoietic system, disorders of the skin and subcutaneous tissue, tumors, endocrine and allergic diseases, metabolic diseases, diseases of the eye, and complications of pregnancy. (BBB)

**45514** OCCUPATIONAL EXPOSURE TO X RAYS IN VETERINARY PRACTICES. O'Riordan, Michael C. (Radiological Protection Service, Belmont, Eng.). Vet. Rec., 82: 22-3 (Jan. 6, 1968).

In Great Britain the average doses received in veterinary practice for 1964 at the surface of the trunk were 0.022 R for women and 0.041 R for men; the doses to the hands were 0.23 R for women and 0.44 R for men. The largest dose incurred was 3.5 R in a month, recorded while the film monitor was being worn on the forearm. The average doses are much less than the maximum permissible doses for workers recommended by the International Commission on Radiological Protection (1965). The contribution of all veterinary personnel to the genetically effective population dose is about 33 R/yr. This is an insignificant addition to the estimated 11,000 R/yr contributed by all other radiation workers. For the average voltage and workload the annual dose in the useful beam at 33 in. would be 100 R, and for the highest workload 1000 R, showing that the maximum permissible doses could easily be exceeded with continual misuse of x-ray equipment. Several members of the profession are suffering from manifest irradiation injuries owing to irradiation of the hands and other parts of the body by the useful beam. Such occurrences may occur with low average doses; unless the useful beam impinges on the monitoring device the recorded dose will be very much smaller than the dose actually incurred by the body. (BBB)

**45515** HOMOGENEOUS IRRADIATIONS IN A BEAM OF HIGH ENERGY PROTONS. STUDY OF THE DEPTH DOSE BY MEANS OF PHANTOMS. de Kerviler, H. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Radioprotection, 3: 1-12 (1968). (In French).

One method for improvement of the homogeneity of the dose distribution consists in the defocusing of the beam by means of classical quadrupole electromagnetic lenses. This method is described, and the determination of the site of the irradiation is studied theoretically. The depth-dose using this method was measured by means of phantoms. The results showed that an irradiation equivalent to a homogeneous irradiation can be realized in a beam of high energy particles having a zero dose gradient in one direct and constant gradient in the perpendicular direction. (J.S.R.)

**45516** AGRICULTURAL MEASURES FOR LESSENING OF RADIOACTIVE CONTAMINATION OF FOODSTUFFS UNDER THE CONDITIONS OF A NUCLEAR WEAPON WAR. Reissig, Herbert (Technische Univ., Dresden). Wiss. Z. Tech. Univ. Dresden, 15: 1161-70 (1966). (In German).

Prompt measures to reduce contamination of domestic agricultural animals and prevent fallout contamination of foodstuffs are discussed. Immediate measures prevent loss of animals because of contamination included placing of herds in mass shelters, use of noncontaminated foodstuffs, washing of animals to remove radioactive fallout, and isolation of animals that had consumed contaminated fodder. Measures for prevention of $^{131}I$ contamination of milk; the handling of stored fodder; the handling of growing food crops; the effects of external $\gamma$ radiation on growing food crops; and the effects of heat radiation are described. Measures for reduction of radioactive contamination of foodstuffs following a nuclear attack are considered in terms of retention of $^{90}Sr$ in soil profiles after treatment with various chemicals and lixiviation, decontamination by scraping away of surface soil with a road grader, and decontamination by deep plowing and sand drainage plowing. Use of Ca or K salts as diluents of $^{90}Sr$ in soil and their effects on plant uptake of $^{90}Sr$, and the reduction of $^{90}Sr$ transfer to milk from fodder by Ca supplementation are discussed. (BBB)

**45517** NUCLEAR FALLOUT AT HRADEC KRALOVE SINCE THE TEST BAN. Santholzer, Vilem (Charles Univ., Hradec Kralove, Czech.). Sci. World, 11: No. 6, 13-16 (1967).

After the 1963 Nuclear Test Ban Agreement atmospheric radioactivity decreased to small values, then increased 10 to 20 fold for short periods in 1964–1967, owing to the nuclear tests in China. Gamma spectrometry demonstrated the radioisotopes of shorter half lives, especially those of Ce, Zr, Nb, and La in fresh fallout. Radiostrontium and radiocesium were the significant isotopes in old fallout. The five nuclear tests carried out by France in French Polynesia in 1966 did not significantly increase radioactivity in Czechoslovakia. These tests took place at ~20° south of the Equator, so that the fresh fallout was mainly over the southern hemisphere. There was only a small increase in radioactivity after the first Chinese test in 1964; a larger increase was caused by the third and fifth explosions in 1966. The large Chinese explosion in 1967 caused only a small increase in Czechoslovakia. Summarized quarterly activities of nuclear fallout from the first moratorium at the end of 1958 to 1967 are plotted. The maximum (1960) was caused by the French explosions in the Sahara. A higher increase was observed at the end of 1961 and it lasted until 1963. None of the Chinese tests caused as high an increase in Czechoslovakia as did the 1960 Sahara test. The most radioactive rain, about 20 nCi/l occurred in December 1961, after explosions of large devices. Even in May 1963, though the last explosions had been carried out before the end of 1962, there was an increase in activity in the summer, which was also observed in 1964 and 1965, but only of the order of tenths of nCi/l. In the springs of 1966 and 1967, the activity of rain water was about 0.1 nCi/l. In 1967 the maximum activity, due to the fourth and fifth Chinese test explosions, was in the winter months. Determination of the date of the second Chinese explosion (14 May 1965) from fresh fallout activity is demonstrated. At present (September 1967) airborne radioactivity is 0.05 pCi/m$^3$. (BBB)

**45518** EXHALATION OF $^{220}Rn$ AND ITS CONTENT IN THE AIR. Sen'ko, E. E. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 3: 1023-5 (Sept. 1967). (In Russian).

A method and results of measuring the radon-220 exhalation from the ground and its content in the lower atmosphere are discussed. The results of 38 measurements of $^{220}Rn$ exhalation carried out in a dug up field during a dry season during August to November of 1966 showed a mean $^{220}Rn$ exhalation of 0.023 atom/cm$^2$ · sec (or $80 \times 10^{-16}$ C/cm$^2$ · sec) with the order of error of 30 to 40%. Simultaneous measurements of $^{220}Rn$ concentration in the air, 1 m over the ground indicated the presence of 2.5 atom/liter (or $86 \times 10^{-14}$ Ci/liter), which is in agreement with published experimental data. (R.V.J.)

**45519** GAMMA-IZLUCHENIE RADIOAKTIVNYKH VYPADENII. (Gamma Emission of Radioactive Fallout). Izrael, Yu. A.; Stukin, E. D. Moscow, Atomizdat, 1967. 224p.

Characteristics of $\gamma$-emitting fission products in fallout from test explosions are discussed. The gamma field in the air over a plane isotropic source was calculated. The dosage, intensity, and spectral-angular distribution of $\gamma$ radiation in the air over an artificial model of a contaminated area by a primary emitter of energy of 0.32 to 1.69 MeV were estimated. The effects of actual conditions (uneven ground, plant growth, and meteorological conditions) on the $\gamma$ radiation field were determined. (R.V.J.)

**45520** $^{210}Pb$ CONTENT IN FOODSTUFF AND ITS DIETARY INTAKE IN JAPAN. Takata, Naoko; Watanabe, Hironobu; Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 29-34 (Mar. 1968).

Concentration of $^{210}Pb$ in various kinds of Japanese foodstuff was measured in order to investigate the relation between the intake level of the isotope and the dietary habit in the country. Dietary intake of this naturally-occurring radioisotope was estimated to be around 17 pCi per day by use of the statistical data on the daily consumption of individual foodstuff. This dietary intake level of

$^{210}$Pb seemed to be appreciably high relative to that in European countries. Inter-regional difference of dietary intake level that was found in the present investigation may be ascribed mainly to the local variation of the concentration in vegetables. The largest contributor to the total dietary intake of $^{210}$Pb was sea foods since they have a relatively high concentration of the isotope and are consumed to a considerable extent in this country. This was the most characteristic feature of $^{210}$Pb intake in Japan due to traditional dietary habit. (auth)

**45521** RADIATION DOSES RESULTING FROM THE INGESTION OF TRITIATED THYMIDINE BY THE RAT. Lambert, B. E.; Clifton, R. J. (Radiological Protection Service, Sutton, Eng.). Health Phys., 15: 3-9(July 1968).

The distribution and retention of radioactivity in several organs of the rat were investigated following injection and oral ingestion of tritiated thymidine. The passage of tritiated thymidine across the gut was also followed using everted gut sacs. After an injection of 1 mCi tritiated thymidine the bone marrow received the highest dose, about 43 rems. Following oral ingestion of the same amount of radioactivity the dose was much more uniform, all organs receiving about 10 rems. Using the concept of average whole organ dose, orally ingested tritiated thymidine delivers the same doses as a similar quantity of administered tritiated water. (auth) (UK)

**45522** POSSIBILITIES OF THE USE OF SOLID-STATE DOSIMETERS IN THE MEDICAL RADIOLOGY. Toeroek, Istvan Magy. Radiol., 20: 218-26(June 1968). (In Hungarian).

The principles of the function of solid-state dosimeters and the characteristic features of the method are fully discussed. The advantages of the thermo- and photoluminescent dosimeters are pointed out and compared with formerly used dosimeters. In vivo dosimetry yielded especially useful data with the method. The domains of medical radiology are outlined in which the use of solid-state dosimeters is absolutely indicated. (auth)

**45523** SPECIAFIC ACTIVITY OF $^{24}$Na IN RELATION TO MORTALITY OF RATS AS INDICATOR OF NEUTRON IRRADIATION DOSES. Kofranek, Vladimir; Kokes, Antonin; Hraseova, Vera. Prac. Lek., 20: 142-5(May 1968). (In Czech).

The relative dependence of neutron activation of natural sodium was estimated in relation to mortality of laboratory animals and irradiation doses; the values were presented graphically. Within the range of $LD_{20-100/30}$ a specific activity $^{21}Na$ 1.53 — $2.95 \cdot 10^{-4} \pm 12\%$ $\mu$Ci $^{21}Na/mg^{23}Na$ was estimated, with regard to changes of the neutron spectra for all the horizontal channels of the VVR-S reactor in Rez. By comparison of the results above, a survey of the intensity of irradiation dose in man may be achieved by activation of sodium in case of accidental irradiation by a high dose. By this method the dosimetric data, achieved by other types of measurement may be completed. (auth)

**45524** DIAGNOSTIC RADIATION EXPOSURES AND DOSES IN DENTISTRY. Alcox, Ray W. (Public Health Service, Rockville, Md.). J. Amer. Dent. Ass., 76: 1066-8(May 1968).

Exposures and doses in dental radiography and the biological importance of such doses are briefly reviewed. Radiation units and concepts of exposure and absorbed dose are explained. In the United States the average mean exposure per dental film was 1138 mR in 1964, compared with a mean exposure of 45 mR for a radiographic chest examination and 504 mR for a photofluorographic chest examination. The mean exposures were calculated from a random sampling of all types of x-ray machines, from a composite of all machine operating characteristics, and from various film speeds and operating technics. Organs of special interest in dental radiography are discussed in terms of radiosensitivity. The principal contribution to the gonad dose from dental radiography is by scatter radiation. The anatomical location of the female gonads reduces their absorbed dose to about $^1/_5$ that which the male gonads receive under similar exposure conditions. The thyroid dose was of interest because of the possible relation between thyroid irradiation and thyroid cancer; to the lens of eye, because of possible cataract formation; and to the bone marrow, because of leukemia. (BBB)

**45525** POSSIBILITIES FOR REDUCING HARMFUL RADIATION DOSES IN EXTRAORAL ROENTGENOGRAMS. Chvojka, Z.; Novotny, J. (Charles Univ., Hradec Kralove, Czech.). Cesk. Stomatol., 67: 105-9(Mar. 1967). (In Czech).

Measurements were made of the doses produced by the various types of x-ray machines used in extraoral roentgenography. A commonly used diagnostic x-ray machine was compared to a dental x-ray apparatus with respect to hazard and efficiency. The dental x-ray apparatus was used with a 1-mm Al filter and a long cone, and the films were in cassettes with intensifying screens. The doses produced with the dental machine operated at 55 KV and 8 mA were 0.72 R for the transorbital area and 0.65 R for the molars and mandibles, compared to 1.20 and 1.00 R, respectively, without filtration. The technician should stand 2 m away from the tube. The commonly used diagnostic x-ray machine with a long focal distance was difficult to center and the dose was very little less than that with the dental one (0.62 R transorbital and 0.62 R to mandibles). In addition, the head of the machine was not easily manipulated for dental use. It was concluded that the dental x-ray apparatus was the most suitable for extraoral radiography. (BBB)

**45526** PROBLEM OF RADIATION SAFETY DURING GAMMA-GRADUATION WORKS. Korolev, V. I. Gig. Sanit., No. 2, 97-8 (Feb. 1968). (In Russian).

Analysis of individual dosimetric control by means of DC-0.2 dosimeter showed uptake of 58.5 ± 327 mR (from 5 to 160 R) per week and 1.885 ± 0.677 R (from 0.652 to 3.2 R) per year during 1963 to 1966. These doses were within the limits of permissible doses. The danger of overexposure during recharge of the $\gamma$ emitters in calibration of the devices is discussed. (R.V.J.)

**45527** STUDY OF THE EFFICACY OF PROTECTIVE CLOTHING IN A TRITIUM-CONTAMINATED ATMOSPHERE. Billard, Francois; Charamathieu, Andre (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Radioprotection, 3: 13-27(1968). (In French).

The study described has the purpose of determining the efficacy, with respect to tritium, of protective clothing available in France. Nine types of diving suits were studied. Their efficiency was determined as a function of the nature of the material used in their construction, the configuration of the suit, and the resuscitation rate in the suit. The data obtained is shown graphically. The results indicated that the efficiency is primarily determined by its air-tightness. (tr-auth)

**45528** A MANUAL OF INTERNATIONAL LAW. 5th Ed. Schwarzenberger, G. London, Stevens, 1967. 760p. 97s. 6d.

A section is included on the patterns of international law and organisation in the nuclear age. (UK)

**45529** METHODS OF FORMATION OF THE DOSE FIELD OF BREMSSTRAHLUNG WITH AN ENERGY OF 25 MeV. Tsybulskii, B. A.; Lyapidevskii, V. K.; Milshtein, R. S. (Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 13: 24-30 (1968). (In Russian).

The dose field created by bremsstrahlung with an energy of 25 MeV in a homologous medium in different conditions of irradiation is discussed. The lateral and reverse scattered radiation is assessed. The authors substantiate the method of the distribution of depth doses by means of a screen-emitter placed before the irradiated object. It is shown that the distribution of depth doses depends on the material of the emitter, its thickness, distance to the irradiated object and properties of the medium between the emitter and object. (auth)

**45530** THERMOLUMINESCENT CHARACTERISTICS OF IRRADIATED ENAMEL AND DENTIN. Willhoit, D. G.; Poland, A. D. (Univ. of North Carolina, Chapel Hill). Health Phys., 15: 91-3(July 1968).

If a part of the body, e.g., the bones or the teeth, could be shown to exhibit sufficient thermoluminescence response following radiation exposure, then in effect everyone would be wearing a dosimeter. It might then be possible to make an estimate of the lifetime accumulated exposure of an individual based on the thermoluminescence of his teeth. In order to investigate the thermoluminescent characteristics of dentin and enamel as a potential natural dosimeter, their thermoluminescent glow curves after exposure to gamma radiation were compared with the response of a standard thermoluminescent dosimeter, TLD-100 (LiF). It was established that dentin and enamel show significant thermoluminescence, but further investigations are necessary to determine if this may be used to assess radiation exposure to humans. (auth) (UK)

**45531** IONIZING RADIATIONS IN THE ENVIRONMENT: PROBLEMS OF DOSIMETRY, BIOLOGICAL DAMAGE, AND PROTECTION. Calapaj, G. G. (Univ., Padua, Italy). Ann. Sanita Pubblica, 27: 1169-231(Nov.-Dec. 1966). (In Italian).

A survey was made of the effects of environmental irradiation on humans, as seen in the early radiation syndrome and in long-term somatic and genetic effects. The basic principles of the absorption of ionizing radiation energy by living matter, the concepts of absorbed and exposure doses, and the various units for measuring them are outlined. Current methods and instrumentation for x-ray and $\gamma$-ray dosimetry and their fields of application, sensitivity, and limitations are discussed, e.g., free air and thimble ionization chambers, G—M and scintillation counters, photographic emulsions, and thermoluminescent crystals. Results and statistical reliability of epidemiological surveys reported in the literature are reviewed. Effects of environmental radioactivity discussed include blood diseases, leukemogenic and carcinogenic effects, cataract, reduction in fertility and decrease

in lifespan, congenital malformations, prenatal mortality, as well as modifications, of the sex ratio at birth owing to preconceptional irradiation. The concept of maximum permissible dose is examined and the numerical values assigned to it by international agencies are presented along with data concerning environmental doses around x-ray apparatus and γ-ray sources for medical use, and skin, gonad, and bone marrow doses in the most common radiological examinations. Protective measures are then discussed, including increasing distance from the radiation source and exposure time. The thickness and chemical composition of shielding devices are considered both for theoretical effectiveness and in practical applicability, when used with free or sealed radiation sources for diagnostic and, especially, therapeutic purposes. A total of 224 references in the literature are referred to. (BBB)

**45532** THE BODY BURDEN OF $^{137}Cs$ IN NORWEGIAN CIVILIAN PILOTS. **Hannisdahl, Birger; Madshus, Kjell; Stromme, Aksel (Statens Institutt for Stralehygiene, Oslo). Nord. Med., 78: 1161-2 (Sept. 7, 1967). (In Norwegian).**

The $^{137}Cs$ body burden in Norwegian airline pilots was determined in the period 1964 to 1966. The pilots flew transatlantic routes; their age varied from 35 to 45 yr. The average body burdens for 1964, 1965, and 1966 were 44.9, 42.7, and 36.2 nCi, respectively. Three other Norwegian groups served as controls (men living on the West coast of Norway and men and boys living in Oslo). The body burden of the pilots did not differ significantly from that in two control groups from Oslo and was much lower than that in the group from the West coast, where precipitation was about three times higher. In this group the $^{137}Cs$ body burden reached 3400 pCi/Kg body weight in 1964, compared to about 700 for Oslo residents and 600 for the pilots. (BBB)

**45533** USE OF SPECIAL ANALOG COMPUTERS FOR CALCULATING DOSE FIELDS IN RADIATION THERAPY OF MALIGNANT TUMORS. **Ushakov, V. B.; Krongauz, A. I.; Golovan, V. A.; Shagimardanov, N. Sh. (Scientific Research Inst. for Computer Construction, Moscow. Scientific Research Inst. for X Radiology, Moscow). Vestn. Akad. Med. Nauk SSSR, No. 5, 86-91 (1968). (In Russian).**

Three types of data are needed for the calculations: the type of source used for the irradiation and its location; the effect of the source radiation on the medium; and the section irradiated. The radiation energy and the field dimensions would be put into the machine as numerical values. Data on the second item would be entered as empirical formulas derived from experimental results with tissue equivalent phantoms. Data on the section irradiated would be entered as functions of the x and y coordinates of the area in question. The effect of nonhomogeneity of the irradiated medium on the dose distribution can be taken care of by introducing corrections. Possible stages of development of a machine for radiation-therapy use are discussed. In its final form, the machine would be used for calculating dose fields, finding the best irradiation conditions and procedures, and developing methods for obtaining more experimental data and better irradiation procedures. (TTT)

**45534** SELECTION OF OPTIMUM DOSE FIELD FOR IRRADIATION. **Ignat'ev, U. V. (Inst. of Medical Radiology, Obninsk, USSR). Vestn. Akad. Med. Nauk SSSR, No. 5, 91-5 (1968). (In Russian).**

Problems encountered in using statistical testing and linear programming for determining optimum conditions for irradiating malignant tumors are considered. Although first used for x-ray work, linear programming is here considered also for neutron and electron-beam studies. The calculations for neutron therapy presented here are easily converted for other types of irradiation. The mathematical derivation of dose rates inside phantoms is presented. The general principles for setting up a program for machine calculations are discussed, and two methods for statistical testing are described, including the Monte Carlo. (TTT)

**45535** CARCINOGENIC RISK FROM THE USE OF IONIZING RADIATIONS FOR DIAGNOSTIC PURPOSE. **Lenarduzzi, Guerrino; Pistolesi, Gian Franco; Valdagni, Claudio (Univ., Padua). Tumori, 54: 63-72 (Jan.-Feb. 1968). (In Italian).**

This review indicates that the carcinogenic effect of small doses of radiation such as those used for diagnostic purposes is difficult to assess. In practice, it can be evaluated by retrospective studies on large groups of the population. In addition to the hazard arising from the use of substances which are themselves carcinogenic (Thorotrast), injury may arise from methodological errors. The carcinogenic risk due to irradiation in adults has been evaluated as of the order of 20 leukemia and 20 cancer cases in 10 to 20 yr in 1 million people for each rad of exposure. However, irradiation of the fetus for diagnostic purposes leads to an ~40% increase of the oncogenic risk. Radioprotective measures and the restriction of radiological examinations within the limits of well-defined clinical indications help to reduce risk. Other radioprotective measures recommended for use in diagnostic radiology are cited. (BBB)

**45536** THE ACUTE RADIATION SYNDROME, ITS MILITARY-MEDICAL AND TACTICAL-MEDICAL SIGNIFICANCE. **Renfer, H. R. Vierteljahrsschr. Schweiz. Sanitaetsoffiz., 42: 26-30 (May 1965). (In German).**

The present increased need for medico-military personnel to be trained and prepared for casualties of atomic warfare who have developed the acute radiation syndrome following irradiation is discussed. More widespread development of training courses in radiology, nuclear medicine, radiation protection, and dosimetry are required. To help ensure proper care and treatment of the acute radiation syndrome during an emergency, extensive training is required in the measures and organization needed for medical and technical treatment, provision for adequate shelter space, treatment rooms, antiradiation drugs, rations and water, and specialized training of medical personnel in catastrophe medicine, particularly in medical treatment of the acute radiation syndrome. (BBB)

**45537** VETERINARNO-SANITARNAYA EKSPERTIZA PRODUKTOV ZHIVOTNOVODSTVA PRI RADIATSIONNYKH PORAZHENIYAKH. **(Veterinary-Sanitation Assessment of Radiation Injury Effects on Animal Breeding). Karavaev, V. M.; Kolyakov, V. L.; Korzhevenko, G. N. Moscow, Izdatel'stvo Kolos, 1967. 160p.**

Effects of radioactive fall-out on farm animals and veterinary-sanitation assessments of livestock breeding in radiation contaminated environments are reviewed. Composition, structure, and origin of fall-out particles, and damage to livestock from fission products are discussed. Radioinduced injuries from external exposure and from uptake into organisms by grazing and other dietary means are also discussed. Assessments of quantities of fission products in milk and other dairy products are reviewed. 144 references are included. (R.V.J.)

**45538** RESEARCH ON THE ALIMENTARY UTILIZATION OF RADIOCONTAMINATED MILK. **Calapaj, G. G.; Ongaro, D. (Univ., Padua). Nuovi Ann. Ig. Microbiol., 18: 32-47 (Jan.-Feb. 1967). (In Italian).**

The feasibility of human consumption of milk contaminated following a nuclear accident was evaluated. Experiments were conducted on butter and cheese. It was ascertained that in commercial buttermaking the $^{90}Sr$ and $^{137}Cs$ levels in butter did not exceed 2% of the quantities originally present in the whole milk. In pure butter fats the levels of these radioisotopes dropped to less than 0.3%. In the rennet coagulation process the $^{90}Sr$ in the coagulum ranged from 20 to 80% of that present in the milk and decreased regularly as acidity increased. However, the passage of $^{137}Cs$ from milk to the coagulum was independent of acidity, since the $^{137}Cs$ level in the coagulum stayed relatively constant at about 10% of that present in the milk. Laboratory results were confirmed by industrial scale tests on Italian soft cheese. It was concluded that contaminated milk could safely be used in the manufacture of butter, especially butter fat, and in cheese production with use of elevated acidity. Types of cheese not requiring the use of rennet, but only natural acid coagulation, such as cottage cheese, were especially recommended. It was suggested that the residue of whey could be fed to pigs which accumulate $^{90}Sr$ in their skeleton rather than in muscle to remove it irom the food chain leading to man. (BBB)

**45539** LEVEL OF $^{90}Sr$ AND $^{137}Cs$ IN FOOD STUFFS AND WATER AS A RESULT OF GLOBAL FALLOUT DURING THE PERIOD FROM 1963 TO 1966. **Knizhnikov, V. A.; Petukhova, E. V.; Stepanov, Yu. S.; Barkhudarov, R. M. (Inst. of Biophysics, Moscow). Gig. Sanit., No. 1, 11-17 (Jan. 1968). (In Russian).**

Among the fission products falling out together with other global radioactive sediments, strontium-90 and cesium-137 are of the greatest sanitary significance. The main routes of their access to the human body are food stuffs. The highest contamination of food products in the territory of our country was noted in 1963 and 1964. The decrease of the extent of contamination of food products occurred much slower than that of air and the process was of a quite different nature in various regions. The contents of $^{90}Sr$ and $^{137}Cs$ in the main types of food products in 1966 were at an average of 1.5 to 2.5 times lower than their contents in 1963 and 1964. The role of certain types of food products as suppliers of isotopes in the Soviet Union quite different from that of these products in the USA and some countries of Western Europe. In the USSR the main quantity of $^{90}Sr$ and $^{137}Cs$ was supplied to the population with bread. The extent of supply of both isotopes to the rural population in certain Union Republics differed from 1.5 to 2 times; all the urban population received about the same amount of these isotopes. The amount of $^{90}Sr$ supplied by water did not exceed 5% of that supplied by food

stuffs. The sanitary significance of $^{90}Sr$ (expressed as percent of the maximum permissible level) in the country as a whole was somewhat higher than that of $^{137}Ce$. In certain regions only the sanitary role of $^{137}Ce$ was more important. During these years the average access of both isotopes to the population in all the country did not exceed the maximum permissible levels. During 1966 there was a further fall in the amount of $^{90}Sr$ and $^{137}Ce$ in the population. (auth)

**45540** USING TOTAL $\beta$-ACTIVITY DATA FOR THE ASSESSMENT OF RADIOACTIVE ELEMENT CONTENT IN SOILS AND PLANTS. Pavlotskaya, F. I.; Fedoseev, G. A. Pochvovedenie, No. 10, 119-24(Oct, 1967). (In Russian).

Data are presented on individual radioisotope contributions to the total $\beta$-activity of different plants. Because of the absence of correlation between the total value of $\beta$-activity and the deposit into it of $\beta$-radiation of $^{40}K$ and some artificial radioisotopes, the former may be used for approximate assessments of individual radioisotopes. (auth)

**45541** INFLUENCE OF HERBACEOUS VEGETATION ON RADIOACTIVE CONTAMINATIONS IN SOILS. Gedeonov, L. I.; Rosyanov, S. P.; Vinogradova, V. K. Pochvovedenie, No. 10, 124-6(Oct, 1967). (In Russian).

The uptake of fission products by grass and the level of fallout products in soil specimens collected during 1962-64 were evaluated and compared in order to determine the influence of the uptake of fission products by plants and grasses on the level of soil contamination. The correlated and tabulated data collected in the field grass showed contamination by $^{90}Sr$ and $^{137}Cs$ up to $1.3 \times 10^{-9}$ Ci/m$^2$ and $3.2 \times 10^{-9}$ Ci/m$^2$ respectively, and, for $^{144}Ce$ and $^{95}Zr-^{95}Nb$ daughter product up to $4.6 \times 10^{8}$ Ci/m$^2$ and $2.8 \times 10^{-8}$ Ci/m$^2$. Radioactivity from the fallout per unit of the examined soil area was significantly higher. It was estimated that about 20% of fallout radioactive materials were absorbed from the air and retained by the plants and included in the biological cycle. (R.V.J.)

**45542** ENERGY ABSORPTION AT THE INTERFACE BETWEEN TISSUES OF DIFFERENT STOPPING POWERS: RADIATION DOSE IN TISSUE LAYERS NEAR BONE BY INCORPORATION OF AN $\alpha$-EMITTING BONE SEEKER. Kappos, A. D. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 4: 137-45(1967). (In German).

A method for calculating the absorbed dose at points near a plane interface between bone and soft tissue from $\alpha$-emitting nuclides homogeneously distributed in bone is presented. The method is more generalized in relation to other work done in this field by the fact that any experimental or theoretical dependence of soft tissue or bone stopping power upon the energy of the $\alpha$-particle may be used for dose calculation. Results of a calculation with an $\alpha$-particle stopping power fitted to best experimental data known at present are presented. They diverge only little from results received by other authors with a simple power function. The meaning in radiation biology of a mean absorbed dose in microscopic dimensions with a highly inhomogeneous radiation field is discussed. (auth)

**45543** PERMISSIBLE LEVELS OF TRITIUM OXIDE ADMINISTRATION INTO THE ORGANISM. Moskalev, Yu. I.; Shtukkenberg, Yu. M.; Zhuravlev, V. F. Med. Radiol., 13: No. 6, 82-5 (June 1968). (In Russian).

Data on permissible levels of tritium oxide administration into humans for diagnostic purposes are presented. For single administration 150 $\mu$Ci is recommended, in repeated introduction the same amount with intervals not less than 14 days. The maximal annual administration of tritium oxide should not exceed 2400 $\mu$Ci. (auth)

**45544** ASSESSMENT OF THE TISSUE-EQUIVALENCE OF SUBSTANCES IN THE REGION OF X-RAY IRRADIATION. Frolova, A. V.; Kolotilova, V. G.; Gunder, O. A.; Zaplesnichenko, G. P. Med. Radiol., 13: No. 2, 43-7(1968). (In Russian).

The problem of tissue-equivalence of substances used as phantoms and for the measurement of absorbed doses in the range of x-ray radiation, in particular the tissue-equivalence of scintillation plastics is discussed. It is shown that the characteristics of tissue-equivalence only by the effective atomic number of the substance ($Z_{eff}$) is inadequate for the entire range of x-ray radiation emloyed in medicine. The paper contains a table of values of effective coefficients of absorption, obtained from the curves of radiation weakening, for plastic scintillators with different $Z_{eff}$. (auth)

**45545** ANNUAL REPORT OF THE DIRECTOR OF FISHERY RESEARCH, 1967. Lowestoft, Eng., Ministry of Agriculture, Fisheries, and Food, 1968. 135p.

A section is included on radioactive waste disposal, radioecology, and radiobiology. Topics covered include: radiological control, inspection and monitoring at atomic energy and nuclear sites; radionuclides in oyster flesh, other fish, seaweed, etc. (including fall-out); radiation dosimetry of plaice and plaice eggs (LiF); effects of irradiation on fish; associated radiochemical analysis; stable element analysis; instrumentation. (UK)

**45546** DETERMINATION OF INTEGRAL DOSES IN THE TISSUE BY THE METHOD OF CHEMICAL DOSIMETRY. Vakhlakova, T. V.; Mel'nik, A. D.; Ryabukhin, Yu. S. (Inst. of Medical Radiology, Moscow). Med. Radiol., 13: No. 6, 78-81(June 1968). (In Russian).

On a model system (polyethylene film) a technique of determining integral absorbed doses created by closed sources of $^{90}Sr-^{90}Y$ was evolved. The correctness of the technique was confirmed by a direct experiment involving the determination of the value of the integral absorbed dose in rabbit ears. (auth)

**45547** BIOLOGICAL EQUIVALENT OF CURIE AS A UNIT OF CONDITIONAL QUANTITY OF RADIOACTIVE SUBSTANCE. Krupchatnikov, V. M. Gig. Sanit., No. 1, 100-2(Jan. 1968). (In Russian).

Biological equivalence of Curie (BEC) is suggested as a unit for measuring the permissible doses of radioisotoped (PDR) in the air in laboratories, industrial regions, and fallout areas. The unit combines the absolute radioactivity and radiotoxicity. Any isotope can be selected with which permissible concentration in the working area is equal to $5 \times 10^{-14}$ Ci/l. However, from a practical point of view, a standard of 1 Curie of an isotope with established PDR in air equal to $1 : 10^{-10}$ Ci/l is more convenient. A sample problem of determining the air volume necessary for diluting the mixture of radioactive substances to the PDR level was calculated using the BEC unit. (R.V.J.)

**45548** ENVIRONMENTAL RADIATION MONITORING WITH PHOTOGRAPHIC FILM. Barber, Donald E. (Univ. of Minnesota, Minneapolis). Amer. J. Public Health, 58: 957-62(May 1968).

The use of specially packaged films to monitor the radiation environment around a 2-MW swimming-pool reactor is described. During the first monitoring period, 1964-1965, monitoring films from eight stations showed no exposure significantly different from natural background (10 to 15 mR/month). When reactor operation was changed from an irregular schedule involving at least weekly shutdowns to one of continuous operation for 25-day intervals followed by a 3-day shutdown period, the accumulated megawatt-hours increased at a higher rate; the rate of exposure accumulation decreased. Badges located on the exhaust duct from the reactor measured radiation in addition to background during the period from August 26 to December 23, 1965, but showed nothing significantly above the background exposure rate thereafter. The contribution of $^{41}Ar$ to the ambient radioactivity as a result of temperature changes in the pool water is discussed. It was concluded that swimming-pool reactors may contribute less gaseous radioactivity to the environment if they are operated on duty cycles that produced thermal stratification of pool water. (BBB)

**45549** $^{18}F$ SCANNING OF PRIMARY AND METASTATIC BONE TUMORS. Holsti, L. R.; Patomaeki, L. K. (Univ., Helsinki). Ann. Med. Inter. Fenn., 56: 131-5(1967).

The distribution of $^{18}F$ was studied two hours after administration in 76 patients (86 scans), most of whom had metastatic bone lesions, by isotope scanning or by scintillation camera. Preparation and impurities of the isotope and the radiation dose to the patient are reported. The total whole-body and bone marrow doses were 150 and 350 mrad, respectively. The most important advantage of $^{18}F$ compared with $^{85}Sr$ was its short half-life and, consequently, lower radiation hazard. (BBB)

**45550** RADIUM DOSAGE: THE MANCHESTER SYSTEM. SECOND EDITION. Meredith, W. J., (ed.). Baltimore, Williams and Wilkins Company, 1967. 148p. $8.75.

Since the papers that form the basis of this volume are still in great demand although the first of them was published as long ago as 1934, it was deemed desirable that they be presented in one volume as a complete dosage system covering all phases of mould, intra-cavitary and interstitial $\gamma$-ray therapy. The volume is divided into two main parts. Part I consists of the clinical aspects of the constituent papers re-written to form a continuous whole. Nothing that is essential to the use of the system was omitted, but unification has allowed the omission of repetitions; some small additions were made in the light of clinical experience. More attention was paid to examples of the application of the various rules and, in view of the aim of the National Radium Commission to standardize their containers, the examples were almost always worked with tubes and needles appearing on the Commission's list. It was emphasized that the examples are meant to illustrate the use of the

rules and tables and do not necessarily represent the most suitable treatment for the part considered. Every effort was made to keep close to current clinical practice. In Part I no attempt was made to prove or justify any of the rules or data set forth since this was believed unnecessary for their clinical application. The purely physical aspects of the work are found in Part II that consists of the physical sections of the papers presented almost completely in their original form. (B.S.L.)

**45551** RECOMMENDATIONS IN RADIATION HYGIENE AND PRACTICE, FEBRUARY 1968. J. Amer. Dent. Ass., 76: 365 (Feb. 1968).

Dentists have the primary responsibility for the safety of their patients and office personnel in the use of radiation as a diagnostic aid. The following recommendations are made: Use the fastest speed film available (USASI Speed Group rating of "D" or faster). Use only a collimated x-ray machine so that the circular beam striking the skin is not more than 2.75 in. in dia. Make sure the x-ray machine contains filtration of 2 mm of Al equivalent if operating at less than 70 kVp and 2.5 mm of Al equivalent if operating at 70 kVp or above. Use shielded open-end cones to reduce scatter radiation. Use leaded aprons on children and all patients in the reproductive age range as an additional precaution to prevent irradiation of the gonads. Use film holders, bitetabs, or other methods to position film during exposure. The dentist or assistant should never hold a film for a patient. Have periodic radiation protection surveys made of the dental office. Properly expose the x-ray film; overexposure with underdevelopment subjects the patient and office personnel to unnecessary irradiation. (BBB)

**45552** RADIOBIOLOGICAL DATA CONCERNING LOCAL SHIELDING OF ASTRONAUTS. Grigor'ev, Yu. G.; Nevskaya, G. F.; Abramova, G. M.; Ginsburg, E. V.; Kalandarova, M. P. Kosm. Biol. Med., 2: 68-72(Jan.-Feb. 1968). (In Russian).

The effectiveness of local shielding against 250-MeV proton irradiation at a minimum absolutely lethal dose was investigated. The experiments were performed with dogs, using paraffin blocks to shield the head and stomach. The shielded areas constituted one-seventh of the entire body. The criteria employed in the evaluation of shielding effectiveness were: the survival rate, the level of radiation sickness, the immunobiological reactivity (skin bacterial properties in relation to E. coli and dynamics of indigenous micro flora changes), and peripheral-blood and bone-marrow measurements. The control animals exposed to total irradiation all perished from acute radiation sickness after an average of 14.5 days after irradiation. All animals to whom local shielding was applied survived, head shielding being found to be substantially more effective than stomach shielding. Dogs with head shielding showed practically no symptoms of radiation sickness, whereas stomach shielding alone was accompanied by pronounced radiation-sickness symptoms, recovery beginning only after a period of at least four weeks. A discussion or protection mechanisms of shielded portions of the body, particularly the head, reveals the important role of the bone marrow. (IAA)

**45553** X-RAY REGULATIONS. Feasel, Cecil H. (Washington State Dept. of Health, Seattle). J. Amer. Dent. Ass., 76: 461-2(Mar. 1968).

Radiation control measures instituted by the State of Washington are briefly discussed. The State legislature established authority to initiate and maintain a regulatory program to protect the occupation and public health and safety in the use of ionizing radiation. It names the State Department of Health as the radiation control agency. The radiation control section is the operational unit of the department of health for this program. Possession and use of radioactive material require a license from the agency. Other sources of ionizing radiation, including dental x-ray machines, are required to be registered. The radiation control section maintains a file of x-ray machine registrants and performs x-ray protection surveys on these facilities. Compliance is mandatory and noncompliance is classed as a gross misdemeanor. The health department has the authority to initiate injunction proceedings or to impound sources of ionizing radiation when the licensee or the registrant willfully fails to observe the regulations. The Technical Advisory Board on Radiation Control advises the state agency on policy and programs in radiation control and approves the adoption of regulations. (BBB)

**45554** INDUSTRIAL RADIOISOTOPE MONITORING IN BRITAIN CARRIED OUT BY THE RADIOLOGICAL PROTECTION SERVICE. Bland, W. F. pp 165-9 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967.

See CONF-651220.

In Great Britain there are at present about 1,100 industrial users of radioisotopes. In many cases the radioisotopes are incorporated in such devices as thickness gages and level indicators or are employed in γ radiography and are therefore used only as a tool incidental to the business of the firm concerned. Other firms, in particular luminizers, though making considerable use of radioisotopes in their work, operate only on a small scale, having perhaps a dozen or less employees. While large organizations making extensive use of radioisotopes (in particular the United Kingdom Atomic Energy Authority and the Central Electricity Generating Board) can support specialist health physics personnel, it is not economical for firms coming into the categories described above to employ such specialists. Furthermore, the number of specialists available is not sufficient to make this a possibility and it would be wasteful to train more for such purposes. If radioisotopes are to be used safely it is therefore necessary for industrial users to be able to obtain advice and assistance from a specialist staff, in particular when undertaking a new operation or when some accident involving radioisotopes has taken place. The provision of specialist advice and assistance to users of radioisotopes has been one of the prime functions of the Radiological Protection Service since it was established by the Medical Research Council and the Ministry of Health jointly in 1953. The National Physical Laboratory has the responsibility for the provision and maintenance of primary standards of radiation dose and dose rate. The services provided by the Radiological Protection Service are discussed. (C.H.)

**45555** A NOTE ON THE CONCEPT OF EXPOSURE AND ION DOSE. Eisenlohr, Horst H. (Internationale Atomenergie Organisation, Vienna). Strahlentherapie, 135: 414-16(Apr. 1968). (In German).

The term Ionendosis proposed by the German Committee on Radiological Standards has a larger sense than the term exposure, and in fact contains it in the limit case. Ionendosis is related as the ionization equivalent of the absorbed dose directly to the basic unit of dosimetry. Ionendosis is recommended for use at the international level. Two neutral abbreviations are proposed that may be accepted instead of the expression Ionendosis. (auth)

**45556** DOSIMETRY OF ENERGY BASES BY THERMOLUMINESCENCES OF LITHIUM FLUORIDE. Van Espen, E. (Manufacture Belge de Lampes et de Materiel Electronique, Brussels). pp 110-11 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

Previous studies, experiences, and developments in the thermoluminescence of $CaF_2$ made it possible to develop a $CaF_2$ dosimeter produced in a very wide series and giving a satisfactory energy response up to 80 keV. A substantial improvement of the same type of dosimeter made it possible to descend to 50 keV. These improvements were the result of technological modifications and principally of the filtration and correction device of the energy response. However, it appears almost impossible to extend the correction of $CaF_2$ to lower energies. Therefore, study has begun on other materials, principally LiF. A dosimeter with such a material was constructed based on an identical technology to that of the $CaF_2$ dosimeter but with the use as much as possible of light elements. The energy response curve descends easily to 20 keV giving, with no filtration, a sensitivity in excess of approximately 25% at 100 keV. The properties of LiF making it suitable for such uses are the luminescent yield, the time stability, linearity, readable minimum dose, total dose permitted, aging characteristics, and reproducibility. It is concluded that the thermoluminescence of LiF at the present is the method that makes it possible to measure from several mR up to several hundred R with a good reproducibility and an energy response completely satisfactory at the lowest energy of interest in practical dosimetry. (tr-auth)

**45557** IMPROVEMENTS IN RADIOPROTECTION INSTRUMENTS. Guibourg, M.; Herbin, M. pp 101-8 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

Improvements in radiation detection instruments are described. These improvements concern principally a γ rate meter used in a device for the continuous monitoring of atmospheric acitivity. The use of a tissue-equivalent ionization chamber, developed as a result of studies made by the CEA, makes it possible to evaluate in a more precise fashion the risk to the living tissues exposed to γ radiation. Some less fundamental improvements, such as total tightness, resistance to shock, and simplicity of control, are described. During the continuous measurement of the atmospheric

activity, the validity of the results depends principally on the knowledge of the volume of air filtered. An interesting solution is provided by the use of a ROOTS pump with weak output below 10 $m^3$/hr. In addition to easy maintenance, the instrument has low variations of the volume or mass filtered under extreme conditions of use. (tr-auth)

**45558** DOSIMETRY RING OF THERMOLUMINESCENT LITHIUM FLUORIDE. Portal, M. (CEN, Fontenay-aux-Roses, France). pp 104-9 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

The use of photographic emulsions for routine dosimetry of the hands is not satisfactory because of the difficulty of development of small-dimension emulsions. Moreover it is impossible to use a sufficient number of screens to determine the characteristics of the incident radiation and to correct the response of the emulsion. In order to avoid these difficulties, a ring in which thermoluminescent lithium fluoride powder was placed was studied. The physical properties of LiF together with the selection of the geometric characteristics of the container were such that the response of this dosimeter was independent of the type of incident $\gamma$ or $\beta$ radiation. Its response was studied with $\beta$ sources of different energy and satisfactory results were obtained from 2,000 keV. The window of the container was provided with a screen of 7 mg/$cm^2$ of tissue-equivalent plastic material; thus this dosimeter could be used to measure the absorbed dose to the basal layer of the skin. The dimensions of this ring were such that it could be used without difficulty with gloves during manipulation of radioisotopes. (tr-auth)

**45559** BALANCE OF TWO YEARS OF SYSTEMATIC CONTROL OF TIGHTNESS OF SEALED SOURCES USED IN THICKNESS GAUGES. Chanteur, J.; Rebattet, C. F. pp 46-50 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

The technique for the periodic testing of the tightness of sealed radiation sources used in thickness gages whose casings have a thin window is described. The results obtained from three series of periodic tests on almost 400 sources of this type are reported. (J.S.R.)

**45560** DETECTION OF ATMOSPHERIC CONTAMINATION IN LABORATORIES OF HIGH ACTIVITY. Perotin, J. P.; Bal, G. (CEN, Saclay, France). pp 60-4 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

The different types of atmospheric contamination recorded at the radiation control desk of the high-activity laboratory of the Saclay Center of Nuclear Studies are grouped and classified. The records from ionization chambers used as radioactive aerosol detectors are discussed according to the effect of ventilation of the laboratory on atmospheric contamination. Observations made during the breakage of an ampule of $^{85}Kr$; during an incident involving the release of $PuCl_3$; following the deterioration of the cladding of a caisson containing $^{210}Po$; and following atmospheric contamination by tritium-labeled water are reported. Some particle methods which make it possible to characterize the different radiations and which, during the incident, can give a good approximation of the risk encountered by the personnel, are given. (tr-auth)

**45561** CONSIDERATIONS IN THE CONTROL OF ATMOSPHERIC RADIOACTIVITY UTILIZATION OF AN ENTIRELY AUTONOMOUS MATERIAL. Dupoux; Billard; Granier (CEN, Saclay, France). pp 65-8 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

The particular conditions of the control of atmospheric contamination in uranium mines, where the hazard is caused by Rn in the air, have necessitated the development of specialized equipment for both sampling and measurement. A system that employs a scintillation counter with photomultiplier tubes to count the activity on cellulose filters was developed. The performances of the system are discussed. Applications of this type of monitoring system to atmospheric control during incidents in the course of transport of radioisotopes, or of any other applications where it is necessary to dispose of the filter material, are discussed. (tr-auth)

**45562** NEW APPARATUS FOR THE CONTROL OF $\alpha$ AND $\beta$ CONTAMINATION OF THE HANDS. Magnin, M. (Constructions radioelectriques et electroniques du Centre, St-Etienne, France). pp. 69-72 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13-15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

The use of natural or artificial radioelements produces contamination risks that cannot be neglected. Numerous problems are posed in the development of an efficient program for radioprotection. These include protection of detectors against accidental contaminations, simultaneous $\alpha$ and $\beta$ detection, simple presentation of the measurement results, complete interpretation of these results, and adaptation to various particular cases. An $\alpha$-$\beta$ monitor for the hands (transformable into an $\alpha$ monitor or a $\beta$ monitor) is described. This monitor, in addition to provisions for the separation of $\alpha$ and $\beta$ activity, is characterized by a method for presentation of the results directly in doses. The monitor uses a plastic scintillation detector equipped with photomultipliers for the detection of $\beta$ activity and a zinc sulfide detector for $\alpha$ activity, with pulse-height discriminators for the separation of $\alpha$ and $\beta$ activity. (tr-auth) (TSS)

**45563** INSTRUMENTS FOR MONITORING LIQUID AND GASEOUS MEDIA. Stussi, H. (Societe Landis et Gyr, Zoug, Switzerland). pp 73-7 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

The problems involved in the measurement of radioactivity in liquids and gases are discussed, and the sensitivities necessary for monitoring devices are derived from directives of the ICRP concerning the maximum concentrations of radioisotopes. Some solutions of these problems are presented, and illustrated by results of measurements in air and water. Methods for the increase of detector sensitivity are discussed and methods of sample preparation, including mechanical separation of aerosols, absorption of aerosols by activated charcoal, and concentration of aqueous solutions by evaporation are described. The methods used to measure $^{131}I$ content of atmosphere and tritium content of water are described. (tr-auth)

**45564** DETECTION PROBE FOR CONTROL OF $\gamma$ SPECTROMETRY OF CONTAMINATION OF WATER. Debrie, G.; Dieval, M. (CEN, Saclay, France). pp 78-85 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13-15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).

See CONF-651220.

With the development of atomic energy it became necessary to measure the radioactivity of waters on nuclear sites. There is an ensemble of equipment permitting the detection and measurement of the radioactivity of $\alpha$, $\beta$, and $\gamma$ emitters in suspension or in solution. This equipment is not always adapted to the nature of the water (charged waters and sea water). An apparatus for the quallitative and quantitative measurement of radioactivity in water using an immersible $\gamma$ spectrometer is described. This apparatus, because of its sensitivity and resolution, has given excellent results for hydrological and physical oceanographic measurements. It has some interest in the field of radiation protection for the monitoring of waste solutions. (tr-auth)

**45565** DOSES COMMITMENTS. Morgan, K. Z. (Oak Ridge National Lab., Tenn.). pp 171-4 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967.

See CONF-651220.

The concept of the maximum permissible radiation dose for lifetime exposure of 25 rem, as used by both the National Council on Radiation Protection and the International Commission on Radiological Protection, is discussed. It is postulated that every radiation worker has inherited a special bank account or loan agreement for 25 credit units of exposure to be used only once in a lifetime, and that when this is used any future radiation work must be restricted. This analogy is expanded by considering that every person, regardless of his occupation, has inherited a bank account of credit units that may be used up in one or many different ways by dose or dose commitments of a variety of agents, factors, or substances that are unfavorable to sustained life. Examples cited include the inhalation of beryllium, lead fumes, and silicon dust; accidents; burns; heart disease; cancer; emphysema; leukemia; premature aging; and toxic effects of detergents and insecticides. The effects of age and sex on response to and recovery

from the effects of certain noxious agents are discussed. It is pointed out that occupational exposure to one or more of these risk agents may be considered as the spending or using up of credit units. Some of these doses of risk agents may be received in a single event and result in death. Responsible society must set rules and recommendations such that workers in all fields, including nuclear energy, will not overburden themselves, their children, or society with such debts. (C.H.)

**45566** VARIATION OF DOSE IN MAN FROM EXPOSURE TO A POINT SOURCE OF GAMMA RAYS. Snyder, W. S. (Oak Ridge National Lab., Tenn.). pp 7-11 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967.
See CONF-651220.

A Monte-Carlo-type-code was developed for estimation of dose in tissue phantoms for a wide variety of exposure situations. The code was used to study the distribution of dose in a homogeneous phantom that was approximately the size and shape of an adult man exposed to a point source of monoenergetic photons. The photon energies used were 1.0, 0.5, 0.15, and 0.07 MeV. Results are presented in graphic form. (B.S.L.)

**45567** RADIOPROTECTION EQUIPMENT ADAPTED TO THE PROBLEMS OF TRANSPORT OF RADIOACTIVE MATERIAL. Rigaut, H. (CEN, Saclay, France). pp 121-8 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

In all operations involving the transportation of radioactive materials it is necessary, in order to assure the protection of people, to use radiation detection methods permitting the control of radiation emission and contamination. In particular with respect to transportation of radioisotopes the packages containing the sources are monitored from the moment of packaging. Conveyors are equipped with standard radiation monitoring equipment. A list is given of the equipment used together with their characteristics. (tr-auth)

**45568** DOSAGE PRESCRIPTION IN RADIOTHERAPY USING A SLIDE-RULE BASED ON DOSE-TIME-FRACTIONATION RELATIONSHIPS. Worthley, B. W. (Univ. of Adelaide). Australas. Radiol., 12: 160-70(May 1968).

The analytical foundation and manufacture of a dosage prescription slide rule for use with low L.E.T. radiation are described. The rule may be used with orthovoltage and megavoltage acute fractionated therapies for squamous cell carcinoma, Hodgkin's disease, seminoma, osteosarcoma, etc., for squamous carcinoma treated with interstitial, intracavitary and permanent implant methods with radiation sources of known effective half-life. The rule may also be used in the prescription of mixed therapies, e.g., treatments using intracavitary applicators combined with supplementary external beams of x rays. One scale of the rule is easily modified to suit local practice. (auth)

**45569** PROBLEM OF DOSIMETRY OF THE SCATTERED RADIATION FROM TELECOBALT THERAPY. Keller, Hans Ludwig; Dentler, Hans (Technische Hochschule, Munich, Ger.). Strahlentherapie, 135: 409-11(Apr. 1968). (In German).

During $\gamma$-irradiation of the kidney, the gonadal dose, 2.5 times higher than with conventional x rays, was measured using the same parameters. Additional measurements with ionization chambers showed that only a small part of this dose was due to scattering from the body. The largest part of the dose seemed to be due to scattering from the walls of the treatment room. In moving beam therapy the gonadal dose was much lower. The dose was however rather high when the beam after penetrating the body went near a wall or the floor. Finally it was demonstrated that by shielding the ionization chamber at all directions with 1 mm of lead (gonad shield) the gonadal dose was reduced to one-quarter. (auth)

**45570** PROTECTION AGAINST NEUTRON RADIATION UP TO 30 MILLION ELECTRON VOLTS. Recommendations of the National Committee on Radiation Protection and Measurements. National Bureau of Standards Handbook 63. Washington, D. C., National Bureau of Standards, 1967. 93p. GPO $0.40.

Regulations formulated for adequate protection against neutron irradiation are presented. The handbook is based on the most complete information available; information not easily obtained is set forth in some detail. The scope of the handbook extends to neutron energies up to 30 MeV. Neutron protection at reactors was limited to considerations arising in routine operations. (B.S.L.)

**45571** A MODIFIED GRID FOR CONVENTIONAL X IRRADIATION. Palvoelgyi, Richard; Tordy, Bela (Univ., Budapest). Strahlentherapie, 135: 412-13(Apr. 1968). (In German).

The first experience with a grid of the Pálvölgyi type is reported. The grid provoked an anemia of the directly irradiated skin and enhanced the radiation tolerance. This modified grid not only permitted a better skin-sparing, but also had cosmetic advantages. (auth)

**45572** CONGRES INTERNATIONAL SUR LA RADIOPROTECTION DANS L'UTILISATION INDUSTRIELLE DES RADIOELEMENTS, PARIS, 13–15 DECEMBRE 1965. (International Congress on Radioprotection and the Industrial Utilization of Radioelements, Paris, December 13–15, 1965). Paris, Service Central de Protection Contre les Rayonnements Ionisants, 1967. 180p. (CONF-651220). DTIE.

Separate abstracts were prepared for the 33 papers presented at this conference. (C.H.)

*For abstracts of individual papers see: 45554, 45556–45565, 45567, 45574–45582, and 45584–45593.*

**45573** ROENTGENOKYMOGRAPHY IN REDUCED RADIATION LOAD. Korolyuk, I. P. (Inst. of Medicine, Kuibyshev, USSR). Vestn. Rentgenol. Radiol., No. 6, 81-4(Nov.-Dec. 1967). (In Russian).

A method for roentgenokymography in which the x-radiation dose is reduced about 25 times is described. The method differs from that of tele-roentgenokymography in that an additional selection grid is used; the grid absorbs secondary radiations and enhances the image sharpness. A method for roentgenokymography with direct image magnification is also described. (auth)

**45574** TECHNICAL METHODS OF PROTECTION-BIOLOGICAL SHIELDS-VISION-MANIPULATION. Vertut, J.; Dieval, M. (CEN, Saclay, France). pp 87-96 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

In radioprotection it is common to consider only the problems of detection and dosimetry of radiations. Measurements make it possible to be assured with respect to the working environment, but protection is realized only by biological shields that assure the attenuation of radiation and the confinement of contamination. Shields are described that are provided with specialized equipment for vision and manipulation. The equipment studied and developed by the CEA to resolve these numerous problems constitutes a coherent collection of standard French equipment. (tr-auth)

**45575** INDIVIDUAL DEVICES FOR PERSONNEL PROTECTION AGAINST ATMOSPHERIC CONTAMINATION IN LABORATORIES. Werderer, B. (CEN, Saclay, France). pp 97-103 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The apparatus used at the Saclay Center of Nuclear Studies to protect personnel against atmospheric contamination includes rubber face masks, masks fed by bottles of compressed air, and diving suits. Each employee of the center has available at least one gas mask that is provided for him personally. The efficiency of the apparatus can be impaired by leaks between the face plate and the face covering of the mask. These can be discovered by a systematic testing program. The protection of feminine personnel is emphasized. The masks fed by bottles of compressed air are maintained under pressure. Each of these masks can be utilized by a number of persons. Efficiency of the protection thus obtained is discussed. The diving suits are used principally in zones where the destruction of contaminated material is undertaken, particularly in glove boxes used for the manipulation of $^{239}Pu$. They are maintained under pressure with respect to the atmosphere of the working zone. Some defects have, however, been detected in the efficiency of some of this equipment during material destruction. Tests were made to define the cause. The exit of the person wearing the diving suit from the contaminated zone can be the origin of atmospheric contamination of the room. (tr-auth)

**45576** CONTROL OF EFFECTIVENESS OF PROTECTION AGAINST GAMMA RADIATION. Laforest; Papot; Pannetier (CEA, Paris). pp 35-8 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The effectiveness of radiation protection methods during the use of γ sources for industrial radiography and in gages should be evaluated during conditions similar to those in which they are used. Equipment used for γ radiography and meters is described briefly. The importance of the selection of the gamma source and the type of monitoring devices used are discussed. The first systematic monitoring measurements established significant leaks. Measures to be taken to remedy these leaks when they are discovered and to avoid them in the design and construction of equipment are discussed. (tr-auth)

**45577** SECURITY IN THE USE OF RADIOACTIVE SOURCES. Fradin, J. (CEN, Saclay, France). pp 39-45 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

For the past ten years there has been a significant world increase in the fabrication of sealed radioactive sources. This increase is due to the increase of the number of users and to the development of the number of applications, principally in industry. The CEA in France, desiring to develop sealed sources having very broad guarantees, has undertaken a detailed test program parallel with fabrication. These tests have been systematically applied for several years, particularly with respect to the mechanical and thermal behavior of the sources. The results of these tests led to the construction of sealed sources giving complete satisfaction. (tr-auth)

**45578** PRACTICAL CONSIDERATIONS OF THE RISKS IN USING THE GAMMAGRAPHY APPARATUS. Schmit, M. (Centre d'Etudes de Prevention, Paris). pp 12-14 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The results of many years of experience in the practice of gammagraphy and the surveillance of installations using ionizing radiations are reported. In particular the dangers presented by such installations and their prevention, normal risks encountered during normal operation of the apparatus either in fixed or mobile installations, and abnormal risks encountered in the case of accidents are discussed. Two suggestions to improve the prevention of accidents included a training course for operators and the formation of a commission of specialists to evaluate the safety of the apparatus. (tr-auth)

**45579** PROTECTION OF PERSONNEL DURING THE APPLICATION OF THE RADIOISOTOPE METHOD: DETERMINATION OF THE NETWORK OF SURFACE ISODOSES AROUND THE BOILER. Blanc, D. (Faculte des Sciences, Toulouse); Cohen, H.; Maurel, B.; Bouville, A.; Maille, C.; Hossard, A. pp 15-20 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

During the use of mixed $^{186}$Re and $^{188}$Re as a γ source to measure the density of water vapor at various points in boiler tubes by external counting, the boiler operator remains at his usual post. It is therefore necessary to know if he can operate without danger or if there are certain regions around the boiler that should be forbidden. A complete calculation was made of the doses received in all the region around the active zone by extrapolation of the boiler to a rectangular parallel whose lateral faces were active surfaces with uniform emissive density. With the aid of an IBM 7044, computer calculations were made of the radiation dose in the vicinity of a boiler of very large dimensions (height 35 m, length 11 m, and width 9 m) containing 100 tons of water. The activity introduced was 20 μCi/l. The lattice of isodose surfaces up to 20 m from the lateral faces is presented. Against the walls of the boiler, which constituted the most active region, the dose output was 0.45 mrad/hr after the injection of the radioisotope; it then decreased progressively. An analogous calculation was made for the experimental boiler of the Stein and Roubaix test station containing three tons of water. For 20 μCi per liter the dose of the wall contact was far below the maximum permissible value. At 20 cm from the walls dosimeters registered 60 mrad at the beginning of 210 hrs, whereas the calculation corresponding to the most unfavorable conditions resulted in a dose of 90 mrad. (tr-auth)

**45580** CHARACTERISTIC INCIDENTS OCCURRING AT MARCOULE IN THE COURSE OF INDUSTRIAL GAMMAGRAPHY. Rodier, J.; Chassany, M. (CEN, Marcoule, France). pp 21-3 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

Since the beginning of the construction of the Marcoule Center numerous welding controls by gamma radiography have been necessary. Some incidents have led to radiation exposure of personnel. The most characteristic incidents are described in order to determine the causes. The majority was caused by the lack of technical knowledge on the part of the worker; to the lack of theoretical knowledge on the nature of radiation, the biological effects, and the concept of radioprotection; to the absence of detector devices and to their poor functioning when they were used; to the ignorance of personnel of the regulations in force; to defects or to the insufficient maintenance of the radiographic equipment used; and to human error. It is expected that these incidents will increase in number and consequence in spite of controls by a Protection Service. (tr-auth)

**45581** RADIOPROTECTION USED FOR RADIOACTIVE SOURCES FOR THE CONTROL OF GAS PIPES IN FRANCE. Ruault, P. A.; Gatineau, J. P. (Transport du Gaz de France, Paris). pp 24-30 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

In the nondestructive testing of gas pipes in France γ radiography is being used more and more. The difficulties encountered in the application of safety rules are briefly described, distinguishing those that are inherent with respect to the personnel, materials, and conditions of use. For each case the particular safety measures adopted are indicated, and where possible the reasons for the selection are given. The general rules of radioprotection adopted are described with emphasis on the instruction of personnel; medical examinations; control of the operation of equipment; the use of radiation detector devices; periodic calibration of radiation detectors; periodic monitoring of the contamination of equipment; periodic replacement of pieces used during servicing; the gathering of data on personnel, material, and sources; and the inspection of the actual conditions of use of radiation sources. The high importance that should be placed on all regulations concerning work with radioactive sources is illustrated by reports of the severe repercussions on the health of personnel. (tr-auth)

**45582** RADIATION SICKNESS AND PROBLEMS OF RADIOPROTECTION. Karamourtzounis, G.; Serafino, X.; N'Doye, R.; Pouliguen, J.; Breton, P.; Kamara, M. (Hopital Le Dantec, Dakar, Senegal). pp 31-4 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The control of the pleural and peritoneal effusions resulting from malignant illnesses with colloidal suspensions of $^{198}$Au raises the problem of protection of medical personnel against the radiation emitted. The instruments and techniques used for the manipulation of $^{198}$Au without danger in the Laboratory of Radiobiology and Nuclear Medicine of the Institut Ouest Africain de Lutte Contre le Cancer are described. Isodose curves were prepared around the bed of the patient receiving therapeutic doses of $^{198}$Au. The problems of the radioactive patient with respect to the radiation protection of personnel and visitors are discussed in detail. (tr-auth)

**45583** PROBLEMS ON PROTECTION OF INDUSTRIAL USERS OF RADIOISOTOPES. Fisher, C. (CEN, Saclay, France). pp 1-5 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

Problems in the radiation protection of man and personnel against industrial and medical uses of radiations and radioisotopes are briefly reviewed. The different types of applications that are examined were radioactive tracers: activation analysis, industrial circuits, and hydrology; sealed sources: radiography and instruments for dosimetry; intense sources: radiation chemistry and radiosterilization; and neon lights. (B.S.L.)

**45584** EXPOSURE TO RADIOISOTOPES. Amy, L. (Laboratoire Municipal, Paris); Kissel, Ph. pp 144-50 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

In public demonstrations of manipulations of radioactive mate-

rials or demonstrations of the efficiency of a particular material against radiation, there is the possibility of an accidental exposure not only of professionals but also of the general public. It is therefore necessary that radioprotection experts be informed well in advance of such public presentations so that all possible preventive measures can be used. The civil regulations concerning such public demonstrations should be scrupulously followed. The principal regulations concerning public presentation of radioactive sources are given. (J.S.R.)

**45585** RADIOPROTECTION WITHOUT MONITORING. Duhamel, F. (Commissariat a l'Energie Atomique, Paris). pp 151-5 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

Often in practical applications of radioisotopes the persons holding or using the radioactive substances or radiation generators are not specialists. This user should have available certain radiation protection information. These methods and the urgency of their use are examined. The economic feasibility of the use of radioisotopes can be related to the radiation protection methods necessary and their costs. The unit cost of operations using radioisotopes can be placed outside the region of economic feasibility if radiation protection requirements are too numerous or costly. The comparison of the different dangers and of the different responsibilities should make it possible to develop a coherent system in which the costs are equally distributed between the various initiators of industrial atomic energy, the direct users of energy sources, and various beneficiaries. (J.S.R.)

**45586** POSSIBILITIES OF ACTION OF A SOCIETY SERVING IN THE DOMAIN OF RADIATION PROTECTION. Simon, M. pp 156-8 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

Until the development of industrial uses of radioactivity, installations working with radioactive materials were staffed by persons well aware of the dangers and of the precautions to be taken. The increase in industrial and other uses of radiation has placed radioactive materials in installations with no trained group of radiation protection specialists. The need of a service society having available fixed and mobile specialized equipment to assess the radiation dangers in industrial installations is proposed. The functions that would be assumed by such a society are outlined. The Society of Technical Studies and General Enterprises in France is undertaking such a responsibility. (J.S.R.)

**45587** TECHNICAL METHODS OF PROTECTION: TRANSPORTS AND TRANSFERS. Seran, R.; Vertut, J. (CEN, Saclay, France). pp 129-33 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

A biological shield provided only with equipment for remote vision and remote handling can have only limited services in the radiochemical laboratory. The problems posed by the transfer and transport of radioactive materials and solutions are as delicate as those of confinement. The precautions adopted by research laboratories faced with the most difficult problems can be adapted to industries using radioelements. (tr-auth)

**45588** COMPARATIVE STUDY OF LEGISLATION OF MEMBER COUNTRIES OF CEEA IN THE DOMAIN OF PROTECTION AGAINST IONIZING RADIATION. Tonzig, G. pp 134-6 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

A comparative study was made of the legislation concerning protection against ionizing radiation in Germany, France, Italy, Belgium, The Netherlands, and Luxembourg. The principal characteristics of the regulations of each country are indicated and contrasted with those of the other members. (J.S.R.)

**45589** NEW TRANSPORT REGULATIONS OF THE A.I.E.A. CONSIDERATIONS OF TRANSPORTABLE QUANTITIES. Jacquemin, M.; Bouillet, J. (CEN, Fontenay-aux-Roses, France). pp 112-15 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The International Agency of Atomic Energy has published new regulations this year on the transport of radioactive materials. As the preceding regulations, of which it is a revision, it should serve as a model for the regulation of the member nations to facilitate international transportation. The regulations attempt to predict the risk of radiation, contamination, and criticality during transport and to reduce to admissible values the predictable consequences of a grave incident. The criteria on which it bases safety are essentially: the definition of two types of packaging, the classification of radioactive materials into eight groups of toxicity, the fixation of a limit for each group in each type of packaging, the fixation of a limit for each group when the materials have a low specific activity, and precise regulations on the packaging and shipping of fissile material. The revision of the previous regulations has the effect of increasing the admissible limits in packaging, of increasing the number of toxic groups from three to eight, and defining concretely the resistance qualities that the packaging should possess. (tr-auth)

**45590** PRACTICAL ASPECTS OF TRANSPORT REGULATIONS OF RADIOACTIVE MATERIAL. Bouillet, J. (CEN, Fontenay-aux-Roses, France). pp 116-20 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

A brief history is presented of the development of regulations concerning the transportation of radioactive materials, beginning with the recommendations of the International Agency of Atomic Energy. The basic principals on which these regulations are based are reviewed. It is shown how these standards were used in the development of national regulations. The transportation of radioactive materials is examined in detail with emphasis on the regulations concerning encapsulated sources and the confinement envelope of a shielded container. The problems posed by the shipment of $\gamma$-radiography devices are examined. The concrete characteristics of the regulations are stressed. (tr-auth)

**45591** ASPECTS OF REGULATION OF FEMININE OCCUPATION INVOLVING RADIATION RISKS. Failla, L. (Comite National pour l'Energie Nucleaire, Rome). pp 137-43 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965, Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The problem of the regulation of the work of women in atomic energy industry is examined with respect to irradiation dangers. After a presentation and discussion of the statistics of the feminine presence in industry in general in several European countries, the regulations existing in these countries for feminine work are examined. A critical comparison is made between the regulations of each country and the norms established by the IAEA, other international organizations, and EURATOM directives. The limitations proposed by international organizations are compared with legislative restrictions established in each country. In each case these legislative restrictions are more restrictive than the international norms. The consequences on society of the limitations of feminine work are emphasized. These restrictions can cause difficulties in industry where the work is essentially feminine and as a result they can constitute an obstacle to the most simple application of radioisotopes in industry. (tr-auth)

**45592** AMELIORATION OF SECURITY IN THE USE OF INDUSTRIAL RADIOACTIVE SOURCES. Wild, M. R. (APAVE, Paris). pp 159-61 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967. (In French).
See CONF-651220.

The legislative bases for the control of industrial radioactive sources are reviewed. The work of the APAVE in enforcement of these regulations in France and the most significant derelictions by radioisotope users are discussed. (J.S.R.)

**45593** ORGANIZATION OF NATIONAL SUPERVISORY AND CONSULTATIVE SERVICES FOR RADIOISOTOPE USERS IN ISRAEL. Shalmon, E.; Donagi, A. pp 162-4 of Congres International sur la Radioprotection dans l'Utilisation Industrielle des Radioelements, Paris, 13–15 Decembre 1965. Paris, Service Centra de Protection Contre les Rayonnements Ionisants, 1967.
See CONF-651220.

Uses of radioisotopes in Israel have increased considerably throughout the last ten years. The operation of a nuclear research center by the Israel AEC at Soreq has provided mostly the shorter lived type of radioisotopes. However most of the longer-

lived radioisotopes are still being imported, and the main value of the research center in promoting uses of radioisotopes is through its extensive training programs, information, and services to users. At present, there are several hundreds of users of radioisotopes in Israel, among them medical, industrial, agricultural, and research establishments. For several years, Israel had the distinction to be one of the very few countries in the radiation protection field where control of radioisotope users was carried out on a voluntary basis. Whenever such a need was felt by a certain institute, it requested aid from personnel of the Health Physics Department of the Israel AEC. This type of service had many advantages and seemed to operate beautifully as long as the number of isotope users remained limited. However as this number exceeded a certain critical value, this system appeared to break down. Some minor accidents occurred, and the possibility of more serious ones indicated the need of a new arrangement. It was felt that the most effective way would be to include control of radioisotopes in some existing legislation. Hence, Radioactive Materials and Preparations were added to the List of Dangerous Drugs defined in the Israel Pharmacy Ordinance, thus making all work with radioisotopes subject to special permits by the Ministry of Health. As a result, a successful and rapid transition took place smoothly from the voluntary to the compulsory system. (auth)

# Medicine

*Refer also to abstracts 45288, 45299, 45300, 45302, 45303, 45392, 45393, 45436, 45465, 45512, 45542, 45550, 45582, 45668, 45669, 45671, 45672, 45688, 45698, 45702, 45704, 45729, and 45733.*

**45594** TESTING OF THE ANTIPHLOGISTIC EFFECT OF ANTIRHEUMATIC DRUGS. **Seidel, K.; Eckstein, M. (Univ., Jena, Ger.). Muenchen. Med. Wochenschr., 108: 2048-51(Oct. 14, 1966). (In German).**

Antiphlogistic effects of prednisone, phenylbutazone, aminophenazone, nicotinic acid-amidophenyldimethylpyrazolone, and phenyldimethylpyrazolone-methylaminomethanesulfonic acid were tested against uv erythema produced on the inner surface of the upper arm. With the uv lamp used a 4 cm diameter circular erythema was produced within two to six hr after 60 sec irradiation. Erythema intensity was greatest from seven to 12 hr after irradiation, and was retained for 24 hr or more. The degree of skin reddening was measured by a phlogistometer eight hr after irradiation. The drugs were administered after the erythema measurement, and four days later a new erythema response was induced and measured. The ratio of the second measurement to the first was taken as an evaluation of the drug effectivity. The drug most effective in preventing erythema was nicotinic acid-amidophenyldimethylpyrazolone alone or in combination with prednisone. Other combinations were not as effective. The effectivity of the drugs appeared also to be related to the dose given. The greatest decrease in uv erythema response amounted to ~46%, and the minimum response was ~16%. Untreated control studies showed no change in uv erythema response. (BBB)

**45595** ENHANCEMENT OF RADIORESISTANCE IN MICE SIMULTANEOUSLY EXPOSED TO DIMETHYL SULFOXIDE VAPOR AND X IRRADIATION. **LeVan, H.; Thanh-Huong, V. (Univ. of Illinois, Chicago. ATPP Labs., Chicago). Experientia, 24: 712-13(July 15, 1968).**

Three main effects were observed from this study: dimethyl sulfoxide (DMSO) vapor was again confirmed to be a good protective agent against lethal doses of x irradiation; this protection was most effective when the experimental subjects were exposed simultaneously to the drug vapor and radiation; and the effect was still quite significant even when the drug was applied after radiation exposure. (auth)

**45596** CLINICAL AND BASIC STUDIES ON THE SUPERVOLTAGE RADIATION THERAPY FOR CANCER OF THE CERVIX UTERI. **Watanabe, Hidekazu (Kyushu Univ., Fukuoka. Fukuoka Central National Hospital). Fukuoka Igaku Zasshi, 57: 451-505(June 1966). (In Japanese).**

Supervoltage therapy with 15 MV x ray by a Shimazu BT-15 Betatron was carried out in patients with cervical cancer since August 1961. Dose distributions of bodylike water phantom were measured with 15 MV x ray by means of an ionization chamber and compared with $^{60}$Co. With 15 MV x ray the build-up region is from 0 to 3.5 cm, and 10 cm depth dose rate is 76% of the dose at 3.5 cm below the surface. Using two opposing fields with supervoltage machine, the tissue doses are homogeneous, but risk to normal tissue is increased. Rotation therapy with 15 MV x ray permits homogeneous irradiation of a tumor region with high dosage, while the volume dose to normal tissues remains smaller than Cobalt 60. Of 36 cases (8 cases of radiation alone and 28 cases of preoperative irradiation) skin reaction and other changes accompanied with 15 MV irradiation were smaller than those caused by $^{60}$Co irradiation. Histological findings of metastatic lymph nodes with preoperative 15 MV irradiation suggested the possibility of destruction of cancer cells by irradiation with 6,000 rad or more. On the other hand, histological changes of primary tumor of the cervix irradiated with small source radium suggested that in many cases 10,000 rad is still insufficient to destroy the cancer cells. Therefore, it seems 6,000 rad is the minimal level of cancerocidal dose. Relative biological effectiveness (RBE) of supervoltage x ray was measured by means of irradiation to cultured HeLa cells compared with $^{60}$Co $\gamma$-ray and 200 KV x ray. The results are as follows; $^{60}$Co/200 KV : 0.72, 15 MV/200 KV : 0.76. In radiation therapy of malignant tumors, the object of the treatment was to deliver as high a dose as possible to the tumor itself, while doses to normal surrounding tissues were maintained at low levels to avoid undesirable damage. It was demonstrated that 15 MV x ray was suitable for the above-mentioned purpose, namely this therapy is characterized by deep reaching property of the ray, therefore, the main indication of this therapy is for metastatic lymph nodes than primary lesion of the cervix. (NSA of Japan)

**45597** THE EFFECTIVENESS OF RADIOTHERAPY FOR CANCER OF THE ESOPHAGUS. **Cukiersztajn, W. (Institut d'Oncologie, Warsaw). J. Radiol., Electrol., Med. Nucl., 49: 331-8(May 1968). (In French).**

Studies were conducted on 153 patients, 134 of whom were given radiotherapy. Two-thirds of these were treated for epithelial carcinoma and one-fifth for solid tumors. Factors influencing survival included age, sex, duration of the disease, total dose administered, histopathology of the tumor, tumor dimensions, and duration of treatment. The mean survival duration in patients given radiotherapy was 9.8 months; a survival of five years occurred in three cases. A longer survival occurred in cases where the total dose was less than 5500 R with a time distribution over at least seven weeks. A discussion of the causes of early death in relation to duration of treatment is included. (auth)

**45598** TRIAL TESTS OF NEWLY SYNTHETIZED THIAZOLINE DERIVATIVES FOR RADIOPROTECTIVE ACTIVITY. **Shashkov, V. S.; Fedoseev, V. M.; Burkovskaya, T. E.; Saksonov, P. P.; Antinov, V. V.; Evdokimov, Yu. N. Farmakol. Toksikol., 6: 737-8(Nov.-Dec. 1965). (In Russian).**

Studies on radioprotective properties of chemical agents included tests on 22 newly synthesized derivatives of 2-aminothiazoline (2-AT), where the $R_1$ and $R_2$ amino group substituents were H, $CH_3$, $C_2H_5$, $C_3H_7$, $C_4H_9$, $CH_2{=}CHCH_2$, $CH_2(CH_2CH_2)_2$, and $(CH_2CH_2)$, for $R_3$ the ring C atom substituent was: H, $CH_2Br$, or $H_2CS$. The trials were conducted on mice weighing 18 to 22 g. All derivatives appeared to be two or three times more toxic than the parent 2-AT compound. The highest tolerable doses that were used were $\frac{1}{2}$ or $\frac{1}{3}$ the average doses. All derivatives were administered to the mice intraperitoneally in an isotonic solution of sodium chloride 15 to 20 min prior to $\gamma$ irradiation with $^{60}$Co, for a total dose of 850 R and 230 R/min dose rate. Comparison of the percentage of 30-day survivors failed to reveal radioprotective effects of these newly synthesized derivatives of 2-AT. Probably the negative effects were the result of slow formation of the active form of the agents in the mice. This was later tested in vitro, and it was found that the derivatives could only slowly be hydrolyzed to the corresponding mono- and dithiols in aqueous solutions at pH 8 to 9.5 and 18 to 20°C. (BBB)

**45599** COMFORT MEASURES DURING RADIATION THERAPY. **Welsh, Marian S. (Univ. of Pennsylvania, Philadelphia). Amer. J. Nursing, 67: 1880-2(Sept. 1967).**

Care of patients undergoing radiotherapy, particularly nursing measures which reduced side-effects and complications of irradiation, were reviewed. Radioinduced skin lesions and the symptoms of radiation sickness, and their treatment, were discussed. Hospital personnel must take special precautions with the irradiated patient, understanding that the less an external skin radiation reaction was interfered with, the better it healed. No water or soap was used on the treatment area throughout the treatment period and for two weeks afterward. The treatment field was free of dressings and adhesive tape, which would cause further trauma to the skin and which might necessitate shifting the treatment field or perhaps temporarily withholding irradiation. The affected skin was not massaged, and friction from bed linens was prevented. The problem was considered of encouraging adequate nourishment in response to the patient's nausea, vomiting, diarrhea, ulcers in his mouth and alimentary tract, depression, falling hair, weakness, pain, colostomy, or reimplanted ureters. Antinausea drugs such as prochlorperazine (Compazine) helped the patient tolerate the

necessary high-calorie, high-vitamin diet. If a membranous ulcer was evident in the mouth, lidocaine (Xylocaine) mouthwash before each meal helped him eat more comfortably. Care of patients receiving Ra implantation for gynecologic tumors was described in particular. (BBB)

**45600** RESULTS OF PRE-OPERATIVE RADIOTHERAPY FOR SUPRAGLOTTIC LARYNX CANCER. Hendrickson, Frank R.; Liebner, Edwin. Ann. Otol., Rhinol., Laryngol., 77: 222-9(Apr. 1968).

Studies were aimed at determining whether there was an optimum radiation dose level for pretreatment of locally advanced but technically operable epidermoid carcinomas, whether the complications of surgery are significantly greater after irradiation therapy, and whether technically inoperable cancers can be made curable. Patients with advanced but technically operable lesions were randomized by birth date to receive either 2000 or 5000 rad preoperatively. These doses were chosen because they seemed to be the extremes of the preoperative range in use by other clinics. The treatment was given with supravoltage equipment, either $^{60}$Co or 22-MeV x ray, in increments of 200 to 250 rad tumor dose per exposure on a daily fractionation schedule. With the lower dose, surgery followed shortly after completion of treatment, but with the larger dose it was delayed for 4 to 6 weeks to permit the acute reaction to subside before operative healing was demanded. In these patients a high degree of fractionation was necessary to protect the tumor bed and to enhance the therapeutic ratio with the higher dose. In the 2000-rad group, normal tissue damage was less and prompt surgery became the important factor. When the 2000- and 5000-rad groups were compared for supraglottic primary tumors, there was no significant difference. Currently the authors are considering future low dose levels with relatively little fractionation, i.e., 2 doses of 700 rad separated by 48 to 96 hr, that is biologically similar in effect but has obvious advantages in hospital time and surgical acceptance. (BBB)

**45601** THE RADIOPROTECTIVE EFFECT OF GLYCINE DURING X IRRADIATION: RADIOPROTECTION ACCORDING TO THE TIME OF ADMINISTRATION OF GLYCINE. Ghizari, Eugenia (Danielopolu Inst. of Normal and Pathological Physiology, Bucharest). Rum. Med. Rev., 11: 69-72(Nov.-Dec. 1967).

The radioprotection conferred by glycine against inactivation of adenosinetriphosphatase (ATPase) and inorganic pyrophosphatase (PPase) in the mouse liver was studied. ATPase activity in mouse liver markedly decreased after 700-R x irradiation. In irradiated animals sacrificed one hr after irradiation, ATPase activity was 2.69 μmole/g/min as against 5.95 μmole in control animals. At 48 hr after irradiation without protection there was a tendency to return to normal values (4.05 μmole). This was also noted in mice which received glycine. The protection conferred by 520 μmole of glycine appeared as soon as one hr after irradiation. Good protection was also obtained in animals which received the radioprotective substance three and six hr before irradiation. A decrease in PPase values from 1.15 to 0.75 μmole/g/min one hr after irradiation was seen. However, the return to control values was much less accentuated and the values were still reduced 48 hr after irradiation (0.85 μmole) as compared with ATPase. Here too, glycine played a radioprotective role, a net difference being noticeable in the decrease of enzymatic activity in the animals that received glycine and in those that were not protected. The best time for administration of glycine was three hr before irradiation. The -SH groups essential for enzymatic activity could react with the free radicals formed by the action of radiations in aqueous medium. Glycine, following the uptake of free methyl radicals, was converted into sarcosine and betaine, thus eliminating from the medium some of the methyl free radicals that appeared. (BBB)

**45602** THE EFFECTS OF X IRRADIATION AND HYPERTENSION ON THE MESENTERIC BLOOD VESSELS OF THE RAT: A HISTOCHEMICAL, RADIOCHEMICAL, AND AUTORADIOGRAPHIC STUDY. Dutta, L. P. (Medical Coll., Gauhati, India). Indian J. Med. Res., 56: 288-93(Mar. 1968).

The incorporation of $^{35}$S-sulfate in blood vessels as affected by 1000-R x irradiation before or after induction of hypertension was studied in rat mesentery. In Group I (x irradiation prior to hypertension) a segment of mesentery was x irradiated and 28 days later a hypertensive regime was instituted which lasted for 40 days. The animals were sacrificed 68 days after beginning the experiment. In Group II (x-irradiated control) mesentery was x irradiated and the animals sacrificed at the 68th day. In Group III (x irradiation after hypertension) on the 32nd day of the hypertensive regime the mesentery was irradiated. In Group IV (hypertensive control) the hypertensive period lasted for 40 days. Hypertension was produced by unilateral nephrectomy and injection of deoxycorticosterone intramuscularly at a dose of 50 mg/Kg body weight on 0, eight, 18, and 28 days after nephrectomy. Histological observations of the irradiated tissue in the hypertensive animals as compared to the nonirradiated segments clearly indicated that irradiation 60 days prior to production of hypertension made the blood vessels more susceptible to the injurious effects of hypertension. When irradiation was performed after producing hypertension, within the short postoperative period of 8 days, the hypertensive lesions were not similarly intensified. The proliferative vascular lesions of hypertension showed markedly increased sulfate utilization. Irradiation also stimulated the vascular connective tissue to utilize more sulfate, and irradiation and hypertension, when combined, showed an additive effect on increased sulfate metabolism. In a previous study on long-term effects of irradiation on blood vessels, this enhanced rate of sulfate metabolism was taken as evidence of premature ageing of the vascular connective tissue. (BBB)

**45603** RADIOPROTECTIVE EFFECTS OF AET ON MICE. Gubareva, A. V.; Galkovskaya, K. F. (Central Scientific-Research Roentgen-Radiological Inst., Moscow). Med. Radiol., 13: No. 4, 42-5(1968). (In Russian).

Protective effects of AET injected intraperitoneally into white mice exposed to γ radiation were studied. The compound did not prevent sterilization of the ovaries; however, injuries to blood vessels of the ovaries, kidneys, and other organs were reduced. The development of ovarian tumors in the irradiated mice was not prevented by AET. (R.V.J.)

**45604** NAPHTHIDONE, ITS INFLUENCE OF SURVIVAL RATE OF MICE OF THE C3H/Sn LINE EXPOSED TO TOTAL IRRADIATION AND ITS EFFICIENCY IN THE LOCAL X-RAY TREATMENT OF ADENOCARCINOMA OF THE MAMMARY GLAND. Vdovenko, V. M.; Sukovatykh, L. S.; Bobrova, V. N.; Shestakov, A. D.; Khmara, M. E. (Leningrad Radium Inst. Inst. of Oncology and Medical Radiology, Moscow). Dokl. Akad. Nauk SSSR, 178: 1414-17(Feb. 21, 1968). (In Russian).

Naphthidone(2-methyl-1,4 naphthohydroquinone sodium diphosphate) radiosensitization of mammary gland carcinomas in mice exposed to therapeutic total and local x-irradiation was studied. Preparation of the water soluble forms of the vitamin K, its toxicity, and doses were analyzed. Protective effects of the intraperitoneally injected 35 mg/kg doses of the preparation were observed only in mice treated prior to irradiation; in mice treated after the exposure, the treatments with the naphthidone preparation showed negative results. The mean lethal dose of a single intraperitoneal treatment with the preparation was 420 to 430 mg/kg that resulted in animal death within 25 to 30 min. It was suggested that the protective and radiosensitizing properties of naphthidone should be considered in clinical research. (R.V.J.)

**45605** THE ROLE OF METAL CHELATION IN CHEMICAL RADIATION PROTECTION OF ENZYME SYSTEMS, WITH APPLICATION TO CARBOXYPEPTIDASE A. Fultz, Esther D. (Univ. of California, Livermore). Radiat. Res., 34: 544-54(1968).

Carboxypeptidase A and the apoenzyme resulting from removal of its zinc atom were irradiated with x rays in the presence and in the absence of cysteine. Zinc was then replaced in the apoenzyme, and the resulting loss of peptidase activity of holo- and apoenzyme was determined. Under the conditions of these experiments, cysteine gave complete protection to the enzyme, but very little to the apoenzyme. Furthermore, after the apoenzyme was irradiated, its loss of ability to regain peptidase activity on the replacement of zinc ions corresponded closely with its loss of ability to bind zinc ions. The results indicate that the zinc-binding site is the crucial one involved in radiation damage to the enzyme, and that the principal mode of action of cysteine as a radiation protector is its chelation to zinc at this sensitive site. (auth)

**45606** PRESENT STATE AND OUTLOOK OF DEVELOPING MEDICINAL REMEDIES FOR RADIATION SICKNESS. Burenin, P. I.; Pis'mennyi, V. A.; Chernenko, G. T.; Filenko, O. F. Voenno-Med. Zh., No. 11, 28-33(Nov. 1967). (In Russian).

After pointing out the importance of radioprotective agents in treating victims of nuclear accidents or nuclear war, the state of the art is reviewed. The aminothiols such as merkamine, cysteamine, propamine and aminoethylisothiouronine are protective at absolute lethal doses of 700 to 800 R. These substances should be given before the irradiation, and they accumulate in vital organs such as the spleen, liver, intestine and brain. The protective action may be due to the tissue hypoxia that they cause, their ability to capture free radicals, or to their combining with proteins. Large doses that may be toxic in themselves are required for protection against radiation. The indole alkyl amines such as tryptophan and serotonin are also effective as radioprotective agents. They lower the concentration of oxygen in radiosensitive tissue. They are used in cancer patients who require large doses of radiation. Serotonin is valuable in the treatment of hemorrhage. The polysaccharides

such as zein, hyaluronic acid, heparin, dextran, and chrondroitin-sulfate improve the general resistance of the organism to radiation. They are effective even when administered after irradiation. The use of a mixture of polysaccharides or in combination with antibiotics was found to be effective. (TTT)

**45607** HEPATIC SCINTILLOGRAPHY. Jones, E. A. Gut, 8: 418-20(Oct, 1967).

Compounds used for hepatic scintillography were taken up by the Kupffer cells and by the liver cells. Compounds in the first group were all in colloidal form, the exact distribution depending on the sizes of the colloid particles. When the particle size was 5 to 1000 mμ, almost all of the injected dose was taken up by the Kupffer cells in normal subjects. In disease states uptake of colloid would be influenced by changes in hepatic blood flow and in the number and function of the Kupffer cells. The synthetic isotope technetium ($^{99m}$Tc), prepared in the form of a colloidal sulfide, was retained, emitted exclusively γ rays (140 KeV), and had a half life of only six hr. Using $^{99m}$Tc, larger doses of activity could be given, enabling higher count rates, faster scanning speeds, and better collimation to be obtained for less radiation dosage to the patient. Thus, $^{99m}$Tc was probably the agent of choice for routine liver scanning at the present time. Scans using compounds taken up by Kupffer cells and those using compounds taken up by liver cells might show marked differences in patients with hepatomas, but such comparisons would not usually be of diagnostic value. The importance of various liver scanning patterns in various disease states was reviewed and discussed briefly. (BBB)

**45608** GEOMETRIC EFFICIENCY AND OTHER PERFORMANCE CHARACTERISTICS OF FOCUSING COLLIMATORS. Hart, Hiram E. (Montefiore Hospital, New York); Warshaw, Bernard; Stoller, Herbert I. IEEE (Inst. Elec. Electron. Eng.) Trans. Bio-Med. Eng., BME-14: 96-102(Apr. 1967).

The use of focusing collimators to improve the resolution of radioisotope localization in tissues is considered and expressions are derived for calculating their geometric efficiency directly at the focal plane. The significance of this parameter of collimator performance is discussed. The signal and noise for different collimator parameters were calculated neglecting septa penetration. The dependence of optimal collimator design upon the geometric size and environment of the radioisotope inhomogeneity being sought was examined in detail. A criterion for lesion detectability was formulated that is based upon areal comparisons and that seeks to exhibit explicitly the statistical probabilities of false positive and false negative interpretations. (BBB)

**45609** USE OF RADIOACTIVE ISOTOPES IN CHRONIC SUBDURAL HEMATOMA. Koch, R. D.; Abraham, K. (Medizinische Akademie, Magdeburg, Ger.). Radiol. Diagn., 9: 115-19(1968). (In German).

The γ encephalography with radioactive iodine human serum albumin, $^{197}$Hg-neohydrine or $^{99m}$Tc is unsuitable for the localization of chronic subdural hematomas if they are more than six weeks old. $^{197}$Hg neohydrine can show marked changes in GEG even beyond this period. In spite of smaller size of its molecules $^{99m}$Tc has no advantage over radioactive iodine human serum albumin. Under special conditions the hematoma can lead to a decrease in γ radiation due to absorption of radiation and increase in the distance between the collimator and the cerebral cortex. (auth)

**45610** ISOTOPE NEPHROCYSTOGRAPHY AS A METHOD FOR THE DIAGNOSIS OF VESICO-URETERAL REFLUX. Kapuscinski, Andrzej (Radiological Inst., Warsaw). Radiol. Diagn., 9: 53-6(1968). (In German).

The possibilities of diagnosing uni- or bilateral vesico-ureteral reflux with the help of isotope nephrocystography are discussed. The vesico-ureteral reflux manifests itself in nephrocystogram through a fall in radioactivity in the vesical curve and simultaneous increase in one or both renal curves. Isotope nephrography alone does not enable the diagnosis of reflux. The author compares the value of isotope nephrocystography with urography and voiding cystography in the diagnosis of vesico-ureteral reflux. (auth)

**45611** POSSIBILITIES OF ORTHOPEDIC TREATMENT OF OSTEORADIONECROSIS OF THE HIP. Fries, G. (Univ., Homburg, Ger.). Geburtsh. Frauenheilk., 28: 41-50(Jan. 1968). (In German).

Other than intestinal and ureteral injury, osteoradionecrosis of the pelvis is one of the most serious complications of radiotherapy for genital carcinoma. The orthopedic treatment of radionecrosis of the hip was discussed and 23 cases were described. The best results were obtained by early treatment with nailing of the femoral neck, prior to or with impending pathological fracture of the neck of the femur. A complete pathological fracture of the neck of the femur could be treated with nailing if the osteoporosis was not too far advanced and if the dislocation was not complete, leading to ischemic necrosis of the head of the femur, so that apposition of the bony fragments could still be accomplished by nailing. If these conditions were not found or if there was pseudarthrosis, a Moore arthroplasty was the treatment of choice to avoid complications and permit early rehabilitation of the patient. (BBB)

**45612** COORDINATION OF THE DOSE DISTRIBUTION OF THE $^{60}$Co TELETHERAPY WITH THE MODERN X RAY DIAGNOSTIC AND NUCLEAR TECHNIQUE. Kuttig, H.; Becker, J. Magy. Radiol., 20: 213-17(June 1968). (In Hungarian).

For efficacious ray treatment of the lymph node metastases, focal doses of 5000 to 6500 R were necessary; ultrahard radiation, given in a different manner and with pendular movement was applied. The different methods of the x ray treatment are described: bisegmental radiation, pendular movement in oblique direction, the displacement of the examining table and the use of a wedge-shaped filter are discussed. In the case of cancer of mammary gland, the irradiation of the parasternal lymph nodes was performed with rays directed at a steep angle to the sternum and with pendular movement. (auth)

**45613** LATE EFFECTS AMONG HIROSHIMA AND NAGASAKI SURVIVORS. Warren, Shields (New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. Lahey Clin. Found. Bull., 17: 1-5(Jan.-Mar. 1968).

The survivors were followed in several groups. Most of the work is concentrated in Hiroshima at present. The most intensively studied group consists of 5000 survivors, many of whom were fairly heavily irradiated, balanced by 5000 matched persons from the unexposed populations. All those known to have been exposed are followed as to longevity, major illnesses, and causes of death. In addition to these, there are many small groups of special categories of cases that are intensively studied, for example, those in utero at the time. A group of 24,000 survivors in the two cities was studied for fertility and contrasted with controls. No significant difference in fertility can be detected, a result anticipated in light of the available experimental evidence. Chromosome studies thus far carried out in the survivors have shown about 1/3 to have abnormalities in one or another of their chromosomes, but there was no correlation between these chromosomal abnormalities and untoward effects. A thorough study of pregnancy terminations among the Hiroshima-Nagasaki survivors is being made. The second generation will be studied also, but no significant changes were found in this generation. A special study was carried out on the long-range effects of the atomic radiation on children who were in utero at the time of the bombing. In many the radiation received was slight and no change was detected. In others the radiation caused some slight stunting of growth and in a few, diminution of the circumference of the head that in very rare instances was accompanied by mental impairment. Exposure to heavy doses of radiation caused an increased incidence of leukemia in a portion of the survivors which was most apparent between 1950 and 1960, and new cases are now appearing at a much lower rate, although still more frequently than in the general population. There is an excess of cancer of the thyroid, particularly in the Hiroshima survivors. (BBB)

**45614** QUANTITATIVE ASSESSMENT OF THE EFFECTS OF COMBINED ACTION OF X-RAY IRRADIATION AND CHRYSOMALLIN ON THE SKIN OF MICE. Svyatukhin, M. V.; Letov, V. N. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 13: No. 2, 72-5(1968). (In Russian).

The state of hair follicles in total preparations of the skin three days after irradiation was studied. Subject to confrontation was the distribution of follicles in different doses of a single irradiation and in combined action. Irradiation in doses of 200, 300, 600, and 800 R caused approximately a similar effect as in combined action of irradiation and chrysomallin in doses of irradiation of 100, 200, 300, and 400 R. The effect of combined action for a dose of 200 R and chrysomallin exceeded that of single irradiation in a dose of 300 R. At the same time the effect of combined action in a dose of 400 R and chrysomallin was somewhat lower than in a single irradiation in a dose of 800 R. The administration of chrysomallin in a dose of 200 μ/Kg four hours after irradiation intensified the effect by 1½ to 2 times. (auth)

**45615** NON-PROTEIN SULPHYDRYL AND GLUTATHIONE CONTENT OF EHRLICH ASCITES TUMOUR CELLS AFTER TREATMENT WITH THE RADIOPROTECTORS AET, CYSTEAMINE, AND GLUTATHIONE. Modig, Hans G.; Revesz, Laszlo (Karolinska Institutet, Stockholm). Int. J. Radiat. Biol., 13: 469-77(1967).

Treatment of Ehrlich ascites cells in vitro with increasing concentrations of cysteamine, AET or glutathione (GSH) resulted

in a proportional increase of the intracellular level of non-protein-bound sulphydryl (NPSH). At equimolar concentrations, the increase in NPSH was greatest after AET-treatment, less after cysteamine and least after GSH. A considerable part of the increase in NPSH after AET- and cysteamine-treatment was attributable to an increase in content of cellular GSH. The increase in intracellular NPSH after GSH treatment was, in part, due to some compound(s) other than GSH. After interruption of AET or cysteamine treatment, the total NPSH content of the cells decreased immediately, but the GSH level continued to increase for some time before it also started to fall. The results were interpreted as indicating that intracellular release of GSH may be a major mechanism for the radioprotection afforded by the substances used in the investigation. (auth)

**45616** INFLUENCE OF pH ON RADIOPROTECTION OF E. COLI BY SULPHYDRYL COMPOUNDS. Stern, M. G.; Blok, Joh. (Inst. for Radiopathology and Radiation Protection, Leiden. Univ., Amsterdam). Int. J. Radiat. Biol., 13: 491-3(1967).

The pH dependence of cysteamine and cysteine protection of Escherichia coli γ-irradiated under nitrogen was studied. Radiation did not cause any loss of SH or change in pH. The protective capacity of both cysteamine and cysteine was strongly influenced by pH, the maximum for cysteamine occurring in the region of pH 7.4 and that for cysteine at about pH 8.0. Glycerol conferred the same degree of protection between pH 6.1 and pH 8.0; for bacteria irradiated in buffer the pH per se had only marginal influence on inactivation between pH 6.0 and pH 8.0. (H.L.W.)

**45617** RADIOPROTECTIVE EFFECT OF 5-HYDROXYTRYPTAMINE AND ADRENALECTOMY. Streffer, Christian (Univ., Freiburg i. B.). Int. J. Radiat. Biol., 13: 495-7(1967).

Four groups of mice were x-irradiated. The first group served as a control; the second group was adrenalectomized six days before radiation; the third group was injected with 5-hydroxytryptamine 5 min before radiation; the fourth group was adrenalectomized six days before, and injected with 5-hydroxytryptamine 5 min before radiation. The tabulated results show that the adrenalectomized animals were more radiosensitive than controls and the 5-hydroxytryptamine protected both intact and adrenalectomized animals. (H.L.W.)

**45618** RADIOSENSITIZATION BY MONOIODOACETIC ACID. I. STUDY OF THE RADIOSENSITIZING MECHANISM OF THE MONOIODOACETIC ACID. Grigoresco, St.; Nastase, M.; Nedelco, C.; Apostolesco, R. (Centre de Radiobiologie et de Biologie Moleculaire, Bucharest). Int. J. Radiat. Biol., 13: 433-47(1967). (In French).

To determine the mechanism of mammalian radiosensitization by means of monoiodoacetic acid, the following experimental investigations were performed: The action of monoiodoacetic acid on the lethal effect of whole-body irradiation. The histopathological study of radiosensitized rat organs by means of monoiodoacetic acid. Dynamics and distribution of monoiodoacetic acid-$^{131}$I, in rats. The action of monoiodoacetic acid associated with thyroxine on the lethal effect of whole-body irradiation. Incorporation of monoiodoacetic acid $^{131}$I in thyroxinized rats. The action of monoiodoacetic acid on the incorporation of $^{14}$C-labeled amino acids (L-leucine, DL-serine and DL-phenylalanine). The action of cysteine on the toxicity of the monoiodoacetic acid depending on the cysteine dose. The action of cysteine on the radiosensitizing effect of monoiodoacetic acid. And the action of monoiodoacetic acid on the activity of catalase and peroxidase. The main conclusions are: The cysteine acts mainly with the monoiodoacetic acid; it removes the toxic effect of the high doses of monoiodoacetic acid and hinders the radiosensitizing effect of the latter. The radiosensitization by means of monoiodoacetic acid was histologically revealed at the level of radiosensitive organs and there was no agreement between the degree of radiosensitization and the quantity of monoiodoacetic acid-$^{131}$I accumulated in the given organ. (auth)

**45619** SPHINCTER-SAVING EXCISION IN SEVERE PROCTOSIGMOID IRRADIATION INJURIES. Scheinin, T. M.; Kivioja, O. (Univ. of Turku, Finland). Acta Chir. Scand., 133: 584-90(1967).

Six patients were subjected to sphincter-preserving excision after severe irradiation injury of the proctosigmoid. The interval between irradiation, mostly for cervical cancer, and bowel resection varied between four months and 10 years. The five patients with cervical cancer had received 5900 to 8844 mg-hr of Ra (in some instances also radiocobalt) in three applications, in addition to subsequent x-ray therapy, 5910 to 8400 R to 4 ports. The sixth patient was given two series of x-ray therapy, the first consisting of an unknown dose and the second of 4200 R. All patients were incapacitated by symptoms caused by rectosigmoid strictures, ulcers, and/or fistulas. Conservative measures had failed to relieve the condition. Anterior rectosigmoid resections were carried out on four patients and sphincter saving pull-through type procedures on two. At follow-up, 10 months to 7 years later, five patients were alive, four of them with normal or satisfactory bowel function and control of bowel movement. The fifth patient had a recurrent stricture as a result of inadequate excision of diseased bowel. A sphincter-saving excision appears to be justified in the treatment of some patients with serious proctosigmoid radiation injury if conservative measures have proved unsuccessful. The best results were obtained after resection of sigmoid or high rectal lesions. Results after pull-through type procedures for low rectal injury were, although satisfactory, not as favorable. (BBB)

**45620** VASCULAR INSUFFICIENCY IN MALIGNANT TUMORS: RADIOTHERAPEUTIC ASPECTS. Rubinstein, Elias (Radiumhemmets, Stockholm). Nord. Med., 78: 117-19(Jan. 25, 1968). (In Swedish).

The relation of oxygen tension in tumors and their radiosensitivity was discussed. Adequate oxygenation could produce a three-fold enhancement of radiosensitivity in some tumors. The example was cited of a tumor with $10^{10}$ cells with an average $LD_{30}$ of 400 rad. After irradiation of this tumor with 4800 rad the risk of a surviving cancer cell was ~1%. In an anoxic tumor a dose of 8000 rad would be required to achieve the same risk. Even at a very early stage, malignant tumors showed tendencies toward vascular insufficiency owing to intensive and uncontrolled epithelial proliferation, which was beyond the growth capacity of the subjacent capillary bed. This led to impaired capillary flow in the tumor and eventually to hypoxia or anoxia within large areas, resulting in reduced radiosensitivity. How this phenomenon could be studied both morphologically and physiologically was described. To enhance their radiosensitivity, it was important to try to correct the vascular insufficiency of malignant tumors and to increase the partial oxygen tension in the tumor tissues. The simplest method was oxygen inhalation, but this method had limited value in tumors in which intercapillary distances were great. In these tumors the effect of the oxygen treatment on radiosensitivity was absent. (BBB)

**45621** SELECTIVE PROTECTION OF MARROW AND OTHER ORGANS AGAINST IRRADIATION BY USING SUBSTANCES LINKED WITH MACROMOLECULAR AND CORPUSCULAR CARRIERS. Svet-Moldavskii, G. Ya.; Pavlotskii, A. I. (Inst. of Experimental and Clinical Oncology, Moscow). Dokl. Akad. Nauk SSSR, 177: 1223-4(1967). (In Russian).

A selective uptake of protective preparations linked with corpuscular and macromolecular carrier was studied in marrow, spleen, and liver. Toxicity and protective effects of cystamine in aqueous solution and adsorbed by the carriers were studied using female mice BALB weighing 12 to 14 g. A complete absorption was observed with pH 7.0 with the cystamine:carrier ratio of 1:6. Results obtained with mice x-irradiated with 800 R doses, 20 R/min showed that injections with cystamine with the adsorbent produced milder toxic effects than injection in solution. Studies with identical doses of adsorbent and nonadsorbent doses of cystamine (150 μ/kg) (50 μ/kg intraveneously and 100 μ/kg per os) introduced 2 hr before exposure to 500 R showed that in the case of adsorbent cystamine treatment the mice did not exhibit any pathological symptoms while the mice treated with cystamine in solution died 10 days later. (R.V.J.)

**45622** EFFECT OF ERYTHROPOIETIN ON THE GROWTH AND DEVELOPMENT OF SPLEEN COLONY-FORMING CELLS. Schooley, John C. (Univ. of California, Berkeley). J. Cell. Physiol., 68: 249-62(Dec. 1966).

The progressive growth and development of spleen colonies was studied in heavily irradiated host mice in which erythropoiesis was modified by various procedures. Female $C_3H$/Cum mice weighing 19 to 25 g were irradiated with $^{60}$Co at doses which varied between 872 and 960 R in the different experiments. Erythropoietic activity in nonpolycythemic hosts bearing spleen colonies was not increased by injections of exogenous erythropoietin. Detectable levels of erythropoietin were found in the heavily irradiated host mice suggesting that the failure of exogenous erythropoietin to modify erythropoiesis was because the host mice were already maximally stimulated by the high endogenous erythropoietin levels. Spleen colonies did not become erythroid in polycythemic mice. Injection of exogenous erythropoietin into heavily irradiated polycythemic hosts did not decrease the total number of spleen colonies produced by a given bone marrow transplant, as would be expected if erythropoietin acted directly on the colony-forming cells. Comparison of growth curves for colony-forming cells in the spleens of polycythemic hosts either receiving or not receiving erythropoietin indicated that the overall doubling time of colony-forming cells during the first 10 days after transplantation was not changed by

the daily injection of erythropoietin. Evidently erythropoietin is necessary for the development of erythroid colonies, and acts upon some progeny of the colony-forming cell rather than the colony-forming cell itself. (BBB)

**45623** EXPERIENCE WITH ANTIRADIATION PROTECTION OF THE CENTRAL NERVOUS SYSTEM DURING ANTENATAL IRRADIATION OF RATS. Piontkovskii, I. A.; Gol'dberg, M. B. (Inst. of Higher Nervous Activity, Moscow). Byull. Eksp. Biol. Med., 65: No. 5, 41-4(May 1968). (In Russian).

The conditioned reflex method was used to study the protective effect of amino-ethylisothiuronium BrHBr (AET) on the higher segments of the central nervous system of antenatally irradiated rats. One group of rats not subjected to ionizing radiation and administration of a protector served as control. Another group was irradiated on the 16th day of embryogenesis by x rays (150 R). The third group was irradiated under same conditions by the same dose, but pregnant females received AET 15 minutes prior to irradiation. AET diminished the radiation reaction and improved the conditioned reflex activity of the antenatally irradiated rats in the postnatal ontogenesis. (auth)

**45624** EFFECTS OF THE COMBINATION OF CYTOTOXIC DRUGS AND X RAYS ON RAT BONE MARROW. CLINICAL FINDINGS. Maisin, H. (Univ., Louvain). Acta Clin. Belg., 21: 302-25(1966). (In French).

Attempts were made to demonstrate synergistic effects between x rays and various cytotoxic drugs. It was suggested that clinical radiotherapy has arrived at the limit of its therapeutic effectiveness in the treatment of solid malignant tumors. The combination of radiotherapy and cytotoxic agents did not give optimal results in experimental work. It was believed that this was because the best schedule of administration of cytotoxics in conjunction with radiotherapy had not been determined. In the studies described the action of alkylating agents, antimetabolites, plant alkaloids, and antibiotics combined with x rays was tested on the variation of the number of nucleated cells of the bone marrow. It was not possible to show a potentiation effect but merely an additive effect of varying degrees. However, the cytotoxic agents could be classified into drugs with weak and short-term action, and those with a more intense and long-term action. In general, the alkylating agents belonged to the first group, except for Myleran; the others belonged to the second type. It was concluded in combination with x rays, doses of the drugs of the first group must be repeated daily, and those of the second group only every three days. It was possible to give a large local dose of radiation to a tumor and increase the action of this dose by a cytotoxic agent administered at a minimal dose. A radioresistant tumor could be cured by such combination therapy. It was shown that the association of a cytotoxic agent of the first group with one of the second group had the same effect as association of x rays and a cytotoxic agent of the second group. The combination of two cytotoxics alone could only be used in exceptional cases, for the effect on immunity was severe. With the most radioresistant tumors, combined use of two cytotoxics with different actions and x rays could be effective. (BBB)

**45625** FURTHER STUDIES ON THE EFFECT OF SERUM ALPHA MACROGLOBULIN ON REGENERATION OF HEMOPOIETIC TISSUE AFTER X-IRRADIATION. Nettesheim, P.; Hanna, M. G. Jr.; Fisher, W. D. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Radiat. Res., 35: 378-89 (1968). (ORNL-P-3553).

A previous study demonstrated that macroglobulin enhanced radiation recovery of hemopoietic tissue. In the present study isologous serum alpha macroglobulin was found to be most effective in promoting regeneration of hemopoietic cells when given shortly after x-irradiation. This effect was enhanced by repeated doses. Macroglobulin had only a slight effect on the hemopoietic cells of unirradiated mice. The macroglobulin of two mouse strains and Sprague-Dawley rats was tested and was found to enhance radiation recovery across strain and species barriers. A dose response of the macroglobulin effect was established. (auth)

**45626** SENSITIVITY OF ACATALASEMIC MICE TO ACUTE AND CHRONIC IRRADIATION AND RELATED CONDITIONS. Feinstein, Robert N.; Faulhaber, Joann T.; Howard, Judith B. (Argonne National Lab., Ill.). Radiat. Res., 35: 341-9(1968).

Acatalasemic mice were no more sensitive, as measured by lethality, than normocatalasemic mice to acute whole-body x-irradiation, chronic whole-body γ-irradiation, or exposure to one or several atmospheres of 100% oxygen. If the animals received a preliminary injection of aminotriazole, which reduces the catalase activity of all solid tissues but does not affect erythrocyte catalase, the actalasemic mice were rendered essentially acatalatic, but were still no more sensitive to the agents and procedures listed. In fact, the data suggested that low body catalase, far from being deleterious, may actually be protective to an animal receiving a single dose of whole-body x-irradiation. On the other hand, the acatalasemic mouse was considerably more sensitive to injected hydrogen peroxide than was the normal mouse; prior injection of aminotriazole further increased this sensitivity. (auth)

**45627** STUDIES ON THE RADIATION PROTECTION ACTIVITY OF METHANDROSTENOLONE IN FEMALE RATS. Danysz, Andrzej; Panek, Ryszard (Pharmakologisches Institut der Medizinischen Akademie, Bialystok, Poland). Strahlentherapie, 135: 459-63(Apr. 1968). (In German).

The radioprotective effect of Methandrostenolone (oral and subcutaneously) in doses of 0.2, 1.0 and 2.0 mg/kg was studied in female rats. Methandrostenolone proved to be very efficient as a protector so far as lethality and hematological modifications were concerned, particularly for hemoglobin and the lymphocyte-leucocyte ratio. The most efficient oral dose seemed to be 1 mg/kg per os (DRF = 1.64). (auth)

**45628** CHANGES IN THE SUPRARENAL CORTEX IN IRRADIATED AND PHARMACOLOGICALLY PROTECTED RATS. Nikolov, P.; Dimitrov, L. (Bulgarian Academy of Science, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 677-80(1966).

Experiments on adrenal function were carried out with 176 albino rats of both sexes after irradiation with 800 R doses of x rays. Irradiated control rats showed a mortality rate of 100% after an average of 7.3 days. Of 46 radioprotected rats injected with a mixture of 12 μM serotonin, 362 μM AET, and 425 μM MEA/kg 5 to 10 min before injection, 37 (80.4%) remained alive on the 90th day after irradiation. The functional condition of the suprarenal cortex was determined on the 3rd or 4th day after irradiation and after their death. The indices used included serum K, Na, ascorbic acid, 17-ketosteroids, 17-ketogenic steroids, and blood pressure. The rats that were lethally irradiated and were investigated in the later periods showed great fluctuations in the indices. Kidney injuries were found in some of the animals. There were diffuse changes in the glomeruli, slight thickening of the capsule, and thickening and partial fibrosis of the glomerular loops. There was slight proliferation in the Henle loops and dystrophic to necrobiotic changes in the convoluted tubules. Others showed hyperplasias or adenomas of the adrenal medulla and atrophy of the cortex. However, the causes of increased arterial pressure were unclear. The combined application of radioprotective compounds (bone marrow and antibiotics) protected the adrenals against lethal irradiation injury for a limited period of time. (BBB)

**45629** USE OF α-AMINO ACIDS IN THE SYNTHESIS OF DERIVATIVES OF 2-AMINOETHANETHIOL AS POTENTIAL ANTIRADIATION AGENTS. Piper, James R.; Stringfellow, Carl R. Jr.; Johnston, Thomas P. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem., 9: 911-20(Nov. 1966).

In multistep syntheses of derivatives of 2-aminoethanethiol as potential antiradiation agents α-amino acids were used as intermediates. The types of compounds synthesized included S-substituted derivatives of 2-aminoalkanethiols, 2-amino-2-methylalkanethiols, and 1-aminocycloalkanemethanethiols (chiefly inner Bunte salts and phosphorothioates), and cyclic dithiocarbamates, in addition to a number of the aminothiols themselves. A convenient method for the preparation of amino acid esters from 2-alkanones and cycloalkanones was developed by combining a modified Strecker amino acid synthesis with the Fischer amino acid esterification. The following products afforded mice good protection against lethal radiation (825-R doses of x rays or 1000-R doses of γ rays): sodium hydrogen S-2-amino-3-methylbutylphosphorothioate, S-2-amino-2-methylpropylthiosulfuric acid, S-2-amino-2-methylpropylphosphorothioic acid, and tetrahydro-1H,3H-thiazole[4,3-c][1,4] thiazine-3-thione. (BBB)

**45630** EFFECT OF ROENTGEN-CONTRAST MEDIA UPON THE DOSE FIELD. Mil'shtein, R. S.; Tsybul'skii, I. B. (Moscow Scientific-Research Roentgen-Radiological Inst.). Med. Radiol., 13: No. 6, 38-40(June 1968). (In Russian).

The dose fields of $^{60}$Co γ radiation and bremsstrahlung with endpoint energy of 25 MeV were investigated with introduction into the water phantom of roentgen-contrast media (barium sulfate suspension and iodolipol). Under certain conditions of irradiation the contribution of the roentgen-contrast media to the distribution of depth doses is quite substantial. (auth)

**45631** USE OF RADIOACTIVE MATERIALS IN THE STUDY OF LUNG FUNCTION. REVISED EDITION. West, J. B. Medical Monograph No. 1. Amersham, Eng., Radiochemical Centre, 1967. 21p.

The use of radioactive gases and other materials to investigate lung function is described under the following headings—Regional ventilation and blood flow (poorly soluble gases—$^{133}$Xe, $^{13}$N; very soluble gases—$^{15}$O); radioactive particles (vein injection of labeled

denatured human serum albumin, followed by lung scanning); clinical applications; other uses of radioactive materials in studying lung function. 58 references. (UK)

**45632** DEMONSTRATION AND LOCALIZATION OF BRAIN TUMORS WITH RADIOACTIVE NEOHYDRIN. zum Winkel, K.; Piotrowski, W.; Klar, E.; Scheer, K. E. (Univ., Heidelberg). Acta Neurochir., 14: 105-25(1966). (In German).

The use of $^{203}$Hg-labeled Neohydrin for brain scanning delivers a dose of about 90 R to the kidneys after injection of 700 μCi. This is due primarily to β irradiation. The whole-body burden is far less than this, and amounts to from 0.05 to 0.1 R. The irradiation dose from $^{99m}$Tc-pertechnetate is considerably less. Positron emitters like $^{64}$Cu, $^{74}$As, and $^{68}$Ga have also been used for brain scintigraphy, but the equipment required to use these radioisotopes is considerably more complex and costly than that required for $^{203}$Hg or $^{99m}$Tc scintigraphy. (BBB)

**45633** RECENT ADVANCES IN KIDNEY SCANNING. Taplin, George V.; Swanson, Leonard A.; Hayes, Michael (Univ. of California, Los Angeles). Lahey Clin. Found. Bull., 16: 361-72 (1967).

A 10-probe rapid scanning device to study the intrarenal transport kinetics of kidney-specific agents, which were solely filtered or mainly secreted is described. Preliminary experimental results with $^{99m}$Tc–Fe-ascorbic acid-glucose complex and chelates of this complex were presented to indicate future advances in differential kidney function assessment by either conventional or dynamic scintiscanning techniques. Sequential scans were performed in dogs with a $^{99m}$Tc–Fe ascorbic acid chelate as the test agent using the Ter-Pogossian x-ray image amplifier scintillation camera. In addition, serial conventional scans were made in dogs using the $^{99m}$Tc–Fe-ascorbic acid-glucose complex as test agent to permit higher resolution scans with greatly reduced radiation exposure. A chelate composed of pertechnetate-ferric chloride-ascorbic acid EDTA (ethylenediaminetetraacetate) was excreted almost solely by glomerular filtration. The renogram contours with this chelate and iodopyracet were identical. Its percentage of urinary excretion (about 25% in 20 min and about 57% in 1 hr) was the same as iodopyracet. There was insignificant accumulation in the thyroid, salivary glands, and stomach. The complex of pertechnetate-ascorbic acid-glucose and ferric chloride was rapidly excreted by the kidneys, but ~20% of the injected dose was retained in the kidney parenchyma for the physical half-life of the pertechnetate. This agent was useful for conventional kidney scanning to three hr after injection when kidney radioactivity levels become relatively constant but still greatly exceeded extrarenal tissue background. Both of these agents were easily and quickly prepared in the laboratory and could be sterilized by Millipore filtration or by autoclaving. (BBB)

**45634** MOLDED APPLIANCES IN RADIUM THERAPY. Pierquin, B.; Janvier, L.; Chassagne, D.; Lecacheux, B. (Institut Gustave Roussy, Villejuif, France). Actual. Odonto-Stomatol., 77: 61-75(Mar. 1967). (In French).

Various techniques and devices for protection of healthy tissues during interstitial γ radiotherapy are reported. The use of molded appliances in radium therapy is discussed. Techniques for using plastic tubes employing small $^{192}$Ir wires are described and discussed. The applications of these principles and devices in the mouth and maxillary area are stressed. (BBB) (TSS)

**45635** NUKLEAR MEDICIN. EN NORDISK LAEREBOG. (Nuclear Medicine: A Scandinavian Textbook). Cederquist, E.; Devik, F.; Hammer-Jacobsen, E.; Munkner, T.; Waldeskog, B. (eds.) Scandinavian University Books. Stockholm, Svenska Bokfoerlaget/Norstedts, 1967. 487p. (In Several Languages).

A textbook is presented on the use of radionuclides in clinical diagnostics, therapy and biomedical research. (Swed)

**45636** SPECIFICITY OF CONVERGENT IRRADIATION WITH GAMMA-UNITS "VOL'FRAM" AND "ROKUS". Ruderman, A. I.; Belotserkovskii, S. E.; Belov, S. A. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 13: No. 6, 61-72 (June 1968). (In Russian).

Methods for setting a program of radiation cap swinging, that allow convergent irradiation to be effected with the source moving along different paths (trajectories), are elaborated. The character of a dose distribution within the tissues of the irradiated object is studied and potentialities of achieving a dose distribution closely approaching by its configuration the shape of the primary focus, of identifying the routes of regional metastasing and of creating possibilities for by-passing critical organs in convergent irradiation are shown. Reference is made to a certain non-uniformity of the radiation load along the width of the incoming field path and a method for its estimation proposed. Procedures for practical utilization of the proposed technique are described. (auth)

**45637** TREATMENT OF BRONCHIAL CARCINOMAS WITH SPECIAL CONSIDERATION OF X-RAY AND TELECOBALT THERAPY. Bublitz, Gunter; Labitzke, Reiner (Auguste-Viktoria-Krankenhauses, Berlin). Strahlentherapie, 135: 513-23(May 1968). (In German).

Between 1948 and 1955, 355 patients with bronchial carcinoma were irradiated. Four groups can be distinguished according to the modality of treatment: orthovoltage x irradiation, telecobalt γ therapy, intracavitary radiocobalt-pearls, and a combination of surgery with radiotherapy. The results of the different treatment methods are analyzed, especially in connection with the tolerance to therapy and survival. A study of the distribution of the different stages within the various age groups, the frequency of the histologic tumor types in each stage and age group, and the relation of these criteria to survival for each treatment group, allows a better insight on the significance of some biological factors on the prognosis of bronchial carcinoma. (auth)

**45638** THE EFFECT OF DOSE RATE IN RELATION TO HYPOXIA, AND THE ROLE OF REPAIR SYSTEMS IN THE GREEN ALGA CHLAMYDOMONAS REINHARDI. Davies, D. Roy; Thorburn, M. A. P. (Atomic Energy Research Establishment, Berkshire, Eng.). Radiat. Res., 35: 401-9(1968).

The survival of cells exposed at a high or a low dose rate to $^{60}$Co γ-radiation, under well-oxygenated and hypoxic conditions, was compared for three strains of Chlamydomonas reinhardi differing in repair activity. In oxygen a dose-rate effect was found in all strains, but in hypoxia the mitigating effect of protracted irradiation was observed only in those strains having a certain type of repair activity. Differences in dose-rate and dose-fractionation effects observed under hypoxic conditions in mammalian and plant cells were considered in relation to possible differential repair activity. (auth)

**45639** CHANGES IN THE NATURE OF THE RADIATION SHIELDING EFFECT OF PROPYL GALLATE DURING PROTON BOMBARDMENT OF POTATOES. Shaidorov, Yu. I.; Gertsuskii, D. F.; Skukina, I. S.; Nikitina, I. V.; Alekseenko, L. V. Kosm. Biol. Med., 2: 18-21(Jan.-Feb. 1968). (In Russian).

Investigation is described of the protective effect of propyl gallate (propyl ester of gallic acid) on the growth and development of potato tuber eyes exposed to bombardment with 660-MeV protons from a cyclotron and to irradiation with doses of 500, 1000, and 3000 rad of gamma rays from a $^{60}$Co source. Tuber eyes soaked with 0.1% propyl gallate solution for 20 hr produced a higher tuber yield than unsoaked control samples, after gamma bombardment. On the other hand, a negative effect of gallic acid on growth and development was apparent in proton-bombarded samples. (IAA)

**45640** EFFECT OF X-IRRADIATION ON GLYCINE TRANSPORT IN EHRLICH ASCITES TUMOR CELLS. Hagemann, Ronald Fred. Iowa City, Iowa, Univ. of Iowa, 1967. 57p. Thesis.

The effect of x irradiation on the active transport of glycine-1-$^{14}$C in Ehrlich ascites tumor cells was investigated. The cells were tested for transport ability immediately after in vitro irradiation in different environmental conditions (I), and at various times after in vitro irradiation (II). In group I experiments, the effect (reduction in transport capability) was more pronounced when the cells were irradiated as a 1:500 suspension than as 1:10. There was a definite enhancement by oxygen and this was similarly observed in both the 1:500 and the 1:10 experiments. Bovine serum albumin exerted a protective influence when present (1:500 cells) during irradiation. Neither the passive permeability to glycine (measured at 0°C) nor the fraction of viable cells in the incubation population (measured by aqueous eosin staining) was significantly different from the control. Irradiation of the medium prior to addition of cells was without effect within the experimental period. The effect of irradiation on transport probably involved the plasma membrane since it was acute; it was influenced by the volume ratio of cells to irradiation medium; and protection by a non-penetrating substance occurred. In group II experiments, the cells were irradiated under insensitive conditions (viz., concentrated and hypoxic) and injected into recipient animals. Transport capability was measured at various times thereafter. It was found that glycine transport ability decreased as a function of time after irradiation. Although the fraction of viable cells in the incubation population also decreased, this was of insufficient magnitude to account for the time-dependent impairment of transport. This second component of radiation action on glycine transport may not represent an effect on the transport sites in the plasma membrane per se, since it was not observed shortly after irradiation. The effect of irradiation on a second transported substance triiodothyronine, was also investigated. The transport of triiodothyronine by Ehrlich ascites tumor cells was not affected by irradiation, neither acutely nor

when measured at various times after exposure. These observations provide further evidence for heterogeneity, at the molecular level, in the membrane transport sites for organic molecules of biological importance. (Diss. Abstr.)

**45641** EXPERIMENTAL AND THEORETICAL STUDY OF RETICULOENDOTHELIAL PHAGOCYTIC FUNCTION. Fred, Richard Kassler. Berkeley, Calif., Univ. of California, 1967. 127p.

Thesis.

A non-steady-state model with three-compartments consisting of the general circulation, liver blood, and reticuloendothelial (RE) cell surface was used to describe reticuloendothelial system (RES) phagocytic function. This model exhibits zero order kinetics for the disappearance of colloid at high concentrations, approximates first order kinetics at intermediate concentrations, and displays first order kinetic behavior at low concentrations. Data obtained using the model were compatible with results obtained from animal experimentation. Analysis of model behavior suggested that at low and intermediate concentrations of carbon the RES did not exhibit its maximal functional capacity; using high doses of carbon, however, the maximum functional capacity of the RES was measured. Experiments with puromycin suggested that protein synthesis did not limit the functional capacity of the RES. Doses of puromycin that profoundly decreased protein synthesis were without effect on phagocytosis. The response of the RES to glucan treatment was studied in sublethally irradiated specific pathogen free (SPF) mice. Glucan, administered intravenously, is believed to produce proliferation of the RES in the liver with a concomitant increase in the RES phagocytic activity. It was found that either 400 R (20 R/min, $LD_{05/30}$) or 600 R (20 R/min, $LD_{10/30}$) or 1000 R (0.5 R/min, $LD_{05/30}$) whole body $^{60}Co$ gamma irradiation inhibited the increase in RES phagocytic activity ordinarily produced by glucan. Normal response to glucan was seen by 6 to 7 days after either 400 R (20 R/min) or 1000 R (0.5 R/min). Recovery after 600 R (20 R/min) occurs within 8 to 10 days. The effect of sublethal irradiation directly on the phagocytic function of the RES was investigated. A spontaneous increase was observed in the RES phagocytic activity after 600 R (20 R/min, $LD_{15/30}$) in conventional (not SPF) mice. This spontaneous increase was inhibited by treatment with non-absorbable antibiotics. SPF mice did not ordinarily display a spontaneous increase in RES phagocytic function postirradiation. However, SPF mice irradiated with 700 R (20 R/min, $LD_{05/30}$) of $^{137}Cs$ gamma did show a small but statistically significant reduction in the ability of the RES to clear a large dose of intravenously administered colloidal carbon (18 mg/mouse). (Diss. Abstr.)

**45642** MATERNAL DYSFUNCTION OF A CONTRIBUTING FACTOR IN EMBRYONIC MORTALITY FOLLOWING X-IRRADIATION OF THE RAT. Ward, William Frederick. Rochester, N. Y., Univ. of Rochester, 1967. 200p.

Thesis.

Irradiation of the mammalian female shortly before mating induces, in the ensuing pregnancy, embryonic mortality that is a function of the level of irradiation and of the time interval between irradiation and mating. The hypothesis has been advanced, and is widely accepted, that virtually all of this embryonic death results from dominant lethal mutations in the oocytes. The increasing mortality with decreasing time interval is attributed to increasing radiosensitivity of the oocyte as it completes the maturation division prior to ovulation. The examination of one aspect of maternal function possibly altered by prefertilization x-irradiation, namely hormone balance, and examination of the relationship between recovery time of the irradiated female and embryonic survival is presented. To examine the effectiveness of hormone therapy, female rats (N = 309) were exposed to 300 R W.B. x-ray on the morning (11 A.M. ±30 min) prior to mating, then assigned to one of 36 progesterone and/or estrogen therapy regimens. Two treatments: 1.0 mg. progesterone (SC) on the afternoon prior to mating, and 7.5 mg. progesterone from days 7 to 12 of pregnancy plus 12.0 mg. progesterone on days 13 to 20 increased ($p < 0.05$) litter size to 7.0 and 7.3 living fetuses per female respectively (vs. 4.5 in irradiated controls). Combining the two successful therapies also resulted in a significant, but not additive increase in average litter size (7.4 living fetuses). The technique of delayed implantation was employed to provide the female with a prolonged recovery time prior to the demands of placentation and embryonic development. Two methods of delaying implantation: administration of Medroxyprogesterone acetate to intact animals and of progesterone to ovariectomized animals were unsuitable for studies of fetal survival. The third technique utilized the natural embryonic diapause occurring in lactating females. Rats irradiated on the day of parturition, and mating that night, were permitted to nurse their litters. Those (N = 13) experiencing diapause (2 to 14 days) maintained significantly more living fetuses than did irradiated controls (6.8 vs. 4.5 per female respectively). The experiments demonstrated that supportive progesterone therapy either on the afternoon prior to mating, or at the time of implantation, or both, significantly increased embryonic survival in female rats irradiated on the day prior to mating. This suggested that irradiation at this time may induce either decreased hormone secretion or target organ refractility during the ensuing pregnancy. Radiation induced embryonic mortality was, to a significant degree, a function of the recovery time of the irradiated female, as evidenced by the observation that prolongation of the preimplantation period had a beneficial effect on embryonic survival in the irradiated rat. These data were relevant to the controversy regarding the etiology of radiation induced embryonic death, and argue against the practice of using embryonic mortality as a quantitative index of preovulatory oocyte radiosensitivity. (Diss. Abstr.)

**45643** WATER AND THE EFFECTS OF RADIATIONS ON MICROORGANISMS. Dumasia, Meher Dinshaw. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1967. 167p.

Thesis.

The survival of certain bacteria during a period of one hour aerosolized from distilled water at different relative humidities ranging from 30 to 90 percent RH was studied. Also, aerosols of the same organisms were subjected to ultraviolet and x irradiation at these different relative humidities. The effect on cell survival of some chemical compounds added to the bacterial suspensions prior to their atomization and subsequent exposure to ultraviolet and x irradiation was examined. The alterations in sensitivity of the organisms to partial desiccation and radiations due to changes in their growth medium were investigated. The rate of death of airborne cells due to drying and irradiations at different relative humidities was shown to be directly related to the amount of bound water still remaining in the cell. Inositol was shown to afford stability to airborne cells against partial desiccation and radiation damage. It was suggested that i-inositol through hydrogen bonding enhanced the survival of these organisms by taking on the role of structural water molecules in a vital macromolecule during drying and so preserve the natural structure of the macromolecule. The behavior to partial drying and ultraviolet irradiations of two lambda prophages in the lysogenic strains E. coli K12 (λ+) and E. coli M3 (λ59) in which the prophage λ59 was a heat inducible mutant of the parent λ+, was investigated. Partial drying at relative humidity levels below 70 percent resulted in the induction of these prophages with maximum induction occurring at the intermediate relative humidity level of 55 percent. The compound i-inositol prevented both the induction of the prophage and its destruction by partial drying and ultraviolet irradiation. It was suggested that the lambda prophage was held to the host DNA through structural water molecules and the removal of these by drying liberated the prophage from the host and resulted in the induction phenomenon. The stability of the free lambda bacteriophages to partial drying and ultraviolet irradiation was also studied. The parent λ+ bacteriophage was more stable then the mutant λ59 phage and further i-inositol was unable to afford protection to these mature viruses. The synthesis of the mature viruses in medium containing inositol gave rise to virus particles that were more resistant to partial desiccation and ultraviolet irradiation. As dehydration is mutagenic and the presence of bound water or inositol increases the resistance of microorganisms to the lethal and mutagenic effects of ultraviolet light, it was suggested that partial desiccation affected the biological activity of DNA. This hypothesis was strengthened by the demonstration of induction of DNA prophages by partial desiccation, its prevention by inositol, and the inability of ultraviolet to increase the number of prophage inductions following desiccation. (Diss. Abstr.)

**45644** EFFECTS OF THIOPYRONIN ON DARK REACTIVATION OF UV, X, AND PHOTODYNAMIC DAMAGE IN SACCHAROMYCES. Lochmann, E.-R.; Stein, W. (Freie Univ., Berlin). Biophysik, 5: 78-84(1968). (In German).

Photoinactivation with thiopyronine and visible light of the colony forming ability of Saccharomyces cells showed no dark reactivation. Small amounts of thiopyronine (3 μg/ml) partially prevented dark reactivation after x irradiation in two diploid strains of Saccharomyces. After uv irradiation of a uv-sensitive strain, dark reactivation was prevented almost completely. This was not the case however with a strain that was normally sensitive to uv. It was concluded from the results that the loss of the ability to repair photodynamic damage was probably due to blockage of the repair system through the presence of the dye. (auth)

**45645** INFLUENCE OF THE PRECEDING ULTRA-VIOLET IRRADIATION ON THE COLLOID-PROTECTING PROPERTIES OF THE BLOOD AND THEIR RELATION TO THE PROTEIN COMPLEXES IN EXPERIMENTAL ATHEROSCLEROSIS. Guz, S. Ya.; Kobozev, G. V. (Inst. of Climatotherapy, Yalta, USSR.

Crimean Medical Inst., Simferopol, USSR). Byull. Eksp. Biol. Med., 65: No. 6, 46-9(June 1968). (In Russian).

It was shown that uv irradiation preceding alimentary hypercholesterolemia tended to increase the colloid-protective (stabilizing) properties of the blood serum proteins and to decrease the coagulating properties of γ-globulin. Total blood cholesterol decreased 1.7 times; the aortic wall was less affected by atheromatous plaques in irradiated animals than in the non-irradiated animals. (auth)

**45646** STUDIES ON THE PREVENTION OF RADIATION-INDUCED LEUKEMIA IN MICE BY HETEROLOGOUS PREPARATIONS OF SPLEEN EXTRACTS AND SERUM. Clewell, Don Bert. Indianapolis, Indiana Univ., 1967. 141p.

Thesis.

It has been shown that sheep spleen extracts contain a protein substance designated RLP (for Radiation-Leukemia-Prevention) that inhibits the development of thymic lymphosarcoma when injected into irradiated C57BL mice. The present study showed that sheep spleen extracts also provided protection to BALB/C mice; C3H mice were found to suffer from a non-specific, radiation-linked, toxic effect brought on by the foreign extract. Spleen extracts failed to reduce mortality in lethally irradiated (550-800 R) mice of strains C57BL/6, C57BL/10, C3H, and Swiss. Extracts also failed to inhibit Rauscher virus leukemogenesis in BALB/C mice. RLP was found to exist in serum as well as spleen, but activity could not be found in 4% preparations of 7S γ-globulin or serum albumin. Studies on spleen showed that very significant activity could be found in a high molecular weight Sephadex (G-200) column fraction. When a 0 to 30% ammonium sulfate fraction (containing RLP) was passed through DEAE cellulose at pH 6.0, activity could not be demonstrated in the eluent. Acrylamide gel electrophoresis studies of both serum and spleen pointed to a few possible bands that might represent the active substance. Combined data suggest that RLP is an α or β-globulin. Acrylamide gel electrophoresis studies of sera taken from irradiated mice pointed to changes in serum proteins that may be involved in the mechanism of radiation-leukemogenesis and/or its prevention by RLP. A very slowly migrating substance was seen to increase in the sera of animals injected with spleen extracts. (Diss. Abstr.)

**45647** THE INFLUENCE OF IONIZING RADIATION ON ACTIVE GLUCOSE TRANSPORT BY RAT INTESTINES AND THE RADIOPROTECTIVE EFFECTS OF AET. Phan Van Duyet; Nejtek, Vilem; Dienstbier, Zdenek (Charles Univ., Prague). Strahlentherapie, 135: 610-15(May 1968). (In German).

Research on the isolated rat intestine, 72 hours after total-body x irradiation of 300, 600, and 1200 R, showed that the transport of water was depressed. The glucose transport was depressed after 600 and 1200 R. The modifications found 2 hours and 10 days after irradiation had no statistical significance, and AET injected at doses of 150 μg/g body weight, 15 minutes before the irradiation normalizes completely the glucose and water transport 72 hours after doses of 300 and 600 R, but had no influence on those animals irradiated with 1200 R. When AET was administered to rats (150 μg/g body weight), 15 minutes before the isolation of the intestine, or added directly to the incubation medium (150 μg/ml), it lowered considerably the transport of water and glucose. At the third day after administration of AET, transport was normal again. (auth)

**45648** IMMUNE REACTIONS AND THEIR RELATION TO HEMATOLOGICAL CHANGES IN RADIATION-PROTECTED AND BONE MARROW-TREATED RATS. Dimitrov, Liebknecht; Nedelkova, Milan (Institut fuer Haematologie und Bluttransfusion, Sofia). Strahlentherapie, 135: 718-23(June 1968). (In German).

The combined administration of MEA, AET, and serotonin had a protective effect on hematopoiesis and the production of antibodies and hemolysins in the cells of the rat spleen, after irradiation with lethal doses of x radiation. The first signs of regeneration for the hematopoietic tissue were found at the fourth day, and for the immunologic reactions at the ninth day, becoming more pronounced at the 15th day. Transfusion of bone marrow after whole-body irradiation and prophylactic administration of radioprotective substances enhanced the protective effect on hematopoiesis, but had no influence on the amount of hemolysin-producing cells in the period immediately following irradiation. (auth)

**45649** PREPARATION OF QUANTITATIVE THREE-DIMENSIONAL SCANNOGRAMS. Setaelae, Kai (Univ. of Helsinki). Strahlentherapie, 135: 422-7(Apr. 1968).

A technique for obtaining quantitative 3-dimensional activity images which allows a rigorous statistical analysis of the activities accreted into organs and tissues is described. The technique with its varieties is presented in the light of some illustrative cases from the present laboratory's files. One way of constructing the images is to utilize perpendicularly arranged activity profile. This method is simple, allowing preparation of numerous 3-dimensional images during one working day. The second way of procedure is to construct images from horizontally arranged activity profiles. This measure results in maps at which the activities and differences between them give mathematical readings the statistical significance of which is immediately apparent along all spatial axes. The statistical significance and sources of error are discussed. It is concluded that the resulting quantitative 3-dimensional activity images contain significantly more information than the conventional surface scannograms. (auth)

**45650** ISOTOPIC RADIOCARTOGRAPHY. Blanquet, P.; Delorme, G.; Vilayleck, S.; Pascal-Suisse, P. (Hopital Saint-Andre, Bordeaux). Ann. Radiol., 11: R229-33(1968). (In French).

The principle of radioisotope scanning is outlined, and the techniques of the method are given. Typical results obtained for a descending goiter, bone metastases from cancers, pulmonary scintigram, and hepatic scintigram are shown. (J.S.R.)

**45651** THE COBALTRON II, A NEW $^{60}$Co-SHORTDISTANCE-THERAPY UNIT. Ehring, Franz; Hellenthal, Wolfgang; Schumann, Johannes (Univ., Muenster, Ger.). Strahlentherapie, 135: 417-21(Apr. 1968). (In German).

The Cobaltron II (TEM) was modified into an apparatus for short distance radiotherapy. The maximal loading possible was 70 Curies of $^{60}$Co. The HVL in tissue could be chosen between 3, 4, 5, or 6 cm. Particular attention was devoted to obtaining sharp delimitation of the field and to low radiation leakage. It was suggested that the apparatus be used for the radiation treatment of head and neck tumors and their regional metastases. Advanced skin carcinoma, especially terebrant basal cell carcinoma could also be treated using the apparatus. (auth)

**45652** EXPERIENCE WITH RADIUM APPLICATORS ENCLOSED IN MALLEABLE SILICON SUBSTANCES. Hittmair, Anton (Univ., Innsbruck). Strahlentherapie, 135: 748-9(June 1968). (In German).

Experience with the application of malleable silicone substance for construction of radium applicators is reported. The radiation exposure time for personnel is considerably reduced, at least by 41%. The applicators can be opened very rapidly to use the containers for other purposes. The substance is not modified physically or chemically by the radiations. (auth)

**45653** PENDELUM IRRADIATION WITH TRANSVERSAL MOVEMENT OF THE AXIS IN $^{60}$Co TELETHERAPY. Kuttig, Helmut; Becker, Helmut (Univ., Heidelberg). Strahlentherapie, 135: 528-33(May 1968). (In German).

The method of $^{60}$Co γ moving beam therapy is described, with displacement of the pendular axis. The influence of the irradiated surface, the distance of the axis, the depth of the axis, and the pendular angle were studied. Isodoses are shown and discussed. A method for the irradiation of the lumbo-aortic lymph nodes is recommended. Practical details are given for the calculation of the tumor dose. (auth)

## Radiation Effects on Animals

*Refer also to abstracts 45380, 45382, 45388–45390, 45395, 45396, 45406, 45411, 45414, 45418, 45429, 45437, 45440, 45442, 45447, 45450, 45458, 45465, 45475, 45479, 45486, 45490, 45494, 45495, 45498, 45500, 45506, 45513, 45514, 45524, 45525, 45530, 45535–45537, 45565, 45594, 45597–45599, 45601–45603, 45611, 45613, 45617, 45619, 45621, 45623, 45627, 45645, 45648, 45729, 45743, and 45744.*

**45654** ACTION OF EXOGENOUS FSH AND INTERNAL $^{32}$P IRRADIATION ON THE OVARY OF THE INDIAN CATFISH, HETEROPNEUSTES FOSSILIS BLOCH. Srivastava, P. N.; Rathi, S. K. (Univ. of Rajasthan, Jaipur, India). Arch. Biol. (Liege), 78: 633-43(1967).

The role of exogenous follicle-stimulating hormone (FSH) in the development of the irradiated fish ovary was evaluated. Female Indian catfish weighing 16 g were injected with 0.5 mg FSH or 10 μCi of $^{32}$P simultaneously with the FSH. A third group was injected with 10 μCi of $^{32}$P alone. All the fish were subsequently given for injections of FSH on alternate days. Forty-eight hr after the last FSH injection, the fish were sacrificed and the effect of FSH examined. The weight of the ovaries in fish injected with FSH alone increased 12% whereas the weight of ovaries of the fish injected with FSH and $^{32}$P rose only 2%. The weight of the ovaries in $^{32}$P-treated fish was reduced 26%. Similar changes were noted in the gonadosomatic index as well. The results showed that at the radiation dose level used in these experiments, radiation did not completely inhibit the response of the ovary to exogenous FSH. (BBB)

**45655** THE EFFECT OF $\beta$ RAYS ON THE CONJUNCTIVAL EPITHELIUM NEAR THE LIMBUS IN THE RAT EYE. AUTORADIOGRAPHIC STUDIES WITH $^{3}$H-THYMIDINE. Suechting, P.; Machemer, R.; Schuster, R. (Univ., Goettingen, Ger.). Arch. Klin. Exp. Opthalmol., 170: 52-61(June 2, 1966). (In German).

A $^{90}$Sr applicator was used to irradiate locally the eye of Wistar rats. The reaction of the epithelium of the conjuctiva near the limbus to $\beta$-ray treatment was investigated from ½ hr to 28 days after exposure to doses of 600, 2400, or 6000 rep. The criterion for the effect of the $\beta$ rays was the change in the DNA synthesis as revealed by radioautography with $^{3}$H-thymidine and the number of mitoses. There was an initial depression of DNA synthesis. After 24 hr this was reversed and, depending on the radiation dose, there was a rebound effect. This overcompensation seemed to result from polyploid cell development. An initial depression was also shown in mitoses, but later there was no difference from that in the controls. Results resembled those seen in the cornea. Since DNA synthesis occurred in the basal cell layer as well as in part of the second layer, these two layers must be included in the stratum germinativum of the conjunctiva. (BBB)

**45656** BLOOD CHANGES IN FEMALE GOATS FOLLOWING DIFFERENT INTENSITIES OF GAMMA RADIATION. Hupp, E. W. (Texas Woman's Univ., Denton); O'Brien, C. A.; Pace, H. B.; Austin, J. W. Tex. J. Sci., 19: 369-74(Dec. 1967).

Pregnant goats were exposed to $^{60}$Co $\gamma$ radiation, either as a single acute 300-R dose at the rate of 100 R/hr, or as three fractions of 100 R separated by 10 days, or delivered as a continuous exposure of 300 R over a period of 20 days. One-sixth of the goats exposed to the acute or continuous irradiation died following irradiation, exhibiting the hemorrhagic syndrome of radiation sickness. A transient drop in hematocrit and hemoglobin values in the continuously irradiated group was the only effect observed on the erythropoietic system. The number of leucocytes was markedly depressed in all three irradiated groups, low values being reached four to 14 days after irradiation. The leucocyte levels in the continuously irradiated group returned to 75% of control values by 30 days after irradiation and remained at that level until 120 days after radiation. The groups receiving acute or fractionated doses exhibited total leucocyte counts about 50% of control from 10 to 120 days after radiation. The depressed leucocyte counts were primarily due to a decrease in lymphocytes. (BBB)

**45657** QUANTITATIVE BEHAVIOR OF PLASMATIC PROTEIN FRACTIONS UNDER RADIOIODINE INCORPORATION AND RADIOCOBALT IRRADIATION. Klemm, Dieter; Hoffmann, Guenther; Musshoff, Karl (Univ., Freiburg i. B.). Strahlentherapie, 135: 437-42(Apr. 1968). (In German).

The radiation damage of bone marrow cells in relation to their cell cycle was studied by autoradiography. The labeling index was determined with $^{14}$C-formate. For the blast cells, the erythroblasts, the promyelocytes and the myelocytes, the labeling index amounted to 50%, for the reticulum cells about 11%. The labeling index of the cells studied was depressed to about one-half by irradiation. Correlation with the cell cycle was studied on cells labeled with 10 min $^{3}$H-TdR pulse. The greatest inhibition of the incorporation of $^{3}$H-TdR in the DNA was observed in the cells irradiated in the late $G_1$ phase and the smallest inhibition was observed when cells were irradiated in the S-phase. No difference was found between the relatively radioresistant reticulum-cells and the radiosensitive blasts and promyelocytes. This discrepancy is discussed in relation to the different labeling indexes. (auth)

**45658** ONTOGENY OF THE APPROACH RESPONSE: A RADIOSENSITIVE PERIOD DURING EMBRYOLOGICAL DEVELOPMENT OF DOMESTIC CHICKS. Strobel, Michael G. (Dalhousie Univ., Halifax, Can.); Clark, Gordon M.; Macdonald, Glenn E. J. Comp. Physiol. Psychol., 65: 314-19(Apr. 1968).

Newborn chicks, irradiated on day 5, 7, 9, or 12 of incubation with 400 R, were compared with nonirradiated controls on approach responses to intermittent light and sound stimuli. Day 7 and day 9 groups had longer latencies and spent less time near the stimulus. Variances between and within subjects were inflated. No effect was detected in day 5 and day 12 groups. In Experiment 2, which tested response under physical strain, effects on latency and variability were present but running speeds did not differ. The irradiation effect was not caused by damage of muscular or sensory apparatus but by affected neurophysiological correlates that were in active differentiation on about day 7. (BBB)

**45659** RADIOTHERAPY OF MALIGNANT DISEASE IN THE AGING. Webster, John H. (Roswell Park Memorial Inst., Buffalo, N. Y.). Geriatrics, 23: 117-23(May 1968).

Late complications of radiotherapy that may introduce particular problems because of advanced age of the patient and the prevention and treatment of these complications are reviewed. After the acute phase of any radiation reaction had subsided, a stage of slowly increasing late changes in the normal tissues included within the radiation fields occurred, including small vessel obliteration, fibrosis, and atrophy. In heavily irradiated skin, care should be taken to prevent direct physical trauma such as razor cuts which could bring about the onset of radionecrosis. More frequently, however, overexposure to sunlight or to cold were precipitating factors. In most instances where radionecrosis of skin occurred, it covered a small area and could be treated conservatively, allowing the damaged tissue to regenerate at its abnormally slow rate without further intervention. Where such a lesion failed to heal, however, the area usually had to be widely excised and reconstructed. The second commonest site of difficulty in the late postradiation period was seen in orally irradiated edentulous patients. It was difficult for them to wear dentures comfortably because of the extreme sensitivity of the atrophic oral mucosa to the pressures exerted upon them. When a mucosal ulcer developed in such a denture-wearing patient, it was best managed by discontinuing the use of the dentures and by good oral hygiene. Patients who had not had their teeth extracted could eventually develop radiation caries, a progressive condition which almost always required eventual extraction of all the affected teeth. Osteoradionecrosis was rarely a serious problem and usually was a most self-limited process. Osteoradionecrosis of severe degree, refractory to treatment and causing severe pain, occasionally required mandibulectomy for its control. Late radiation complications at other sites were rare. These included fractures of weight-bearing bones, persistent cystitis, and occasional rectovaginal or vesicovaginal fistulas. (BBB)

**45660** EARLY AND LATE EFFECTS OF $^{3}$HTDR-LABELED DNA ON ILEAL CELL REPLICATION IN VIVO. Post, Joseph; Hoffman, Joseph (New York Univ. Research Service, N. Y.). Radiat. Res., 34: 570-82(1968).

Studies were made of the early and delayed effects of $H^3$TDR-labeled DNA on the replication kinetics of the ileal cells of three week-old male Wistar rats. Following 1 $\mu$Ci/gm, there were three evenly spaced cycles involving the same cohort of cells. After two and 10 $\mu$Ci/gm, cell replication occurred, but the regular polycyclical pattern observed after 1 $\mu$Ci/gm was disrupted. The effects were greater with 10 $\mu$Ci than with 2 $\mu$Ci. The alterations in cycle pattern were due to radiation and not to thymidine pool dilution. Five weeks after two and 10 $\mu$Ci/gm, when essentially all the previously labeled cells were lost, a labeling dose of 50 $\mu$Ci of $H^3$TDR per rat was administered. At this time, the replication patterns were similar to those observed in three-week-old rats following 1 $\mu$Ci/gm. On the other hand, when 2 $\mu$Ci/gm was given to one-day-old rats, the studies made three weeks later, after a second label of 1 $\mu$Ci/gm, revealed a persistently disrupted replication pattern. Little labeling of ileal cells remained three weeks after the initial 2 $\mu$Ci/gm. There was no evidence of ileal cell necrosis in any animals. The results in ileal cells are considered in relation to previously published studies on coexistent hepatocytes. (auth)

**45661** A STUDY OF THE KINETICS OF BONE MARROW REGENERATION IN THE DOG FOLLOWING PARTIAL AND WHOLE BODY IRRADIATION. Cooper, Philip H. Rochester, N. Y., Univ. of Rochester, 1966. 336p.

Thesis.

The pattern of regeneration of shielded and unshielded hematopoietic marrow following x-irradiation of the entire body or the anterior or posterior half of the body of dogs was investigated. The data reported were collected serially and analyzed with the aim of determining the specific contribution of the shielded half of the body to hematopoietic recovery generally and identifying changes in the kinetics of hematopoiesis during radiation injury and recovery from such injury. Data from blood and marrow were compared with the aim of establishing relationships that existed between the two systems. Special attention was given to enumerating and identifying peripheral blood cells that incorporate $^{3}$H-thymidine under in vitro conditions. Since peripheral blood cells that incorporate the label may serve as stem cells, marrow was examined to see whether these cells occurred in greater than normal numbers during recovery from radiation exposure. Myeloid cell production rates in shielded and exposed marrow were compared with neutrophil appearance rate in the peripheral blood to see whether recovery was largely a function of shielded marrow. It did not appear to be so, for both shielded and irradiated marrow contributed to the neutrophilia. This lack of evidence indicates that shielded marrow did not increase its production of hematopoietic cells to compensate for injured irradiated marrow. (Diss. Abstr.)

**45662** COAGULATION DISTURBANCES IN IRRADIATED DOGS. Poppa, Cecil; Enache, Florica (Inst. of Hematology,

Bucharest). Nucl. Hematol., (Publ. Nucl. Energy), 80-4(May-June 1968).

A study was made of the effect of ionising radiation on blood coagulation in dogs. After a brief survey of the various hypotheses in the literature, and on the mechanism by which hemostasis disorders are produced by radiation, results obtained on two lots of 25 animals each, irradiated (whole-body) with x-ray doses of respectively 75 and 300 R are given. Particulars of methods and techniques are given, and comments made on the results obtained. It was found that the small dose effect was the reverse of that of the large dose; in both cases acting on the megakaryo-thrombocyte system, which is the keystone of the whole hemostatic process. (UK) (auth)

**45663** CYTOLOGY OF ADENOPHYPOPHYSIS OF CASTRATED RATS IRRADIATED BY GAMMA-RAYS. Shaikhov, R. T. (Inst. of Zoology and Parasitology, Tashkent). Uzb. Biol. Zh., No. 6, 62-3 (1967). (In Russian).

Experiments with 367 male white rats irradiated with $^{60}Co$ $\gamma$ rays at 400 R (dose rate of 25 R/sec) thirty days after castration revealed that gonadectomy increased the radiosensitivity of the front fraction hypophysis and partially arrested the development of the post castration changes of the gland. Moreover, it inhibited some cytological secretions and disturbed the secretory activity of basophilic cells. (R.V.J.)

**45664** THE ECG OF THE RAT AFTER HIGH-DOSAGE $^{60}Co$ IRRADIATION. Kluetsch, Karl; Wende, Wolfram; Braun, Heribert; Lohndorf, Werner (Univ., Wuerzburg, Ger.). Arch. Kreislaufforsch., 55: 185-210(Apr. 1968). (In German).

Changes in the electrocardiogram (ECG) were recorded in rats receiving very high doses of thoracic $\gamma$ irradiation. In control, urethan-anesthetized rats there was a close correlation between heart rate and av (atrioventricular) conduction in the ECG. In addition, a linear correlation (QT = $-0.2 \cdot$ heart rate + 170 msec) between the QT interval and heart rate was observed. Irradiation of the thorax with 48,000 R within 10 hr resulted in a statistically significant, reversible decrease of the PR interval, while heart rate and the QRS and QT intervals remained relatively constant. Thorax-irradiated rats died after 74,000 to 94,000 R within five to six hr, probably from central nervous system damage. Local irradiation of the heart region with more than 70,000 R produced a statistically significant bradycardia, an increase of the relative PR duration, and a statistically significant prolongation of the QRS and QT intervals. The ECG revealed at this time widening of the P wave, various av-conduction disturbances, bundle branch block, and an increase in T amplitude. These findings were compatible with hyperpotassemia. Serum K had increased to $7.1 \pm 1.1$ meq/l from 4.5 meq/l in controls. This could result from impairment of the Na pump mechanism or from radioinduced hemolysis. (BBB)

**45665** RADIATION EFFECTS ON HYPOPHYSIS AND ADRENAL CORTEX ACTIVITY. Bagramyan, E. R. (Inst. of Experimental Endocrinology, Moscow). Med. Radiol., 13: No. 4, 14-17(1968). (In Russian).

Radiation effects on adrenal cortex activity and on the functional hypophysis were studied in white rats 4 to 8 days after exposure to x radiation at a lethal dose of 800 R. Results indicated an increase in weight of the adrenal glands and in the amount of corticosterones produced in vitro and secreted into the blood. This indicated increased adrenal cortex functional activity during the development of radiation sickness. Hypophysectomized animals did not exhibit an increased activity of the adrenal cortex. Consequently, the development of cortex hypertrophy and hyperproduction and hypersecretion of corticosteroids were inhibited by the hypophysis. Tabulated data are given on the weight of the adenohypophysis in rats. A second exposure of the rats to radiation after a one-sided adrenalectomy resulted in reduced concentration of the ascorbic acid in the remaining adrenal gland followed by total hypertrophy of the gland within 48 hr. (R.V.J.)

**45666** STUDY ON THE RELATIONSHIP BETWEEN BLOOD PRESSURE AND CHROMAFFINE CELLS OF THE ADRENAL MEDULLA AFTER X-RAY IRRADIATION. Sekiyama, Shigetaka; Iwai, Yuko; Takeuchi, Tadashi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 5-11(Mar. 1968).

The relations between blood pressure and adrenal medullary cells (norepinephrine-containing cells) in adult male rats after whole-body x irradiation (700 R) were studied. Both systolic and diastolic values of blood pressure elevated at 3, 24, and 48 hours after irradiation, but systolic pressure became lower than the normal level at 0.5 and 72 hours ($p < 0.01$). Pulse rate decreased at 3, 72, and 120 hours after irradiation ($p < 0.01$). Although pulse rate showed a tendency to decrease in 24 and 48 hours, it was not statistically significant. Increase in number of norepinephrine-containing cells with marked accumulation of cytoplasmic granules was seen at 3, 12, 24, and 48 hours after irradiation ($p < 0.01$). On the other hand a decrease in number of cytoplasmic granules associated with marked degeneration was observed at 72 and 120 hours. Results indicated a positive correlation between blood pressure and morphological changes of norepinephrine-containing cells. (auth)

**45667** PHOTOREACTIVATION OF AMPHIBIAN CELLS IN CULTURE. Regan, James D.; Cook, John S.; Lee, William H. (Oak Ridge National Lab., Tenn.). J. Cell. Physiol., 71: 173-6(Apr. 1968).

A system whereby photoreactivation of growth and DNA synthesis in uv-irradiated cells and the photoreactivating-enzyme activity of cell-free extracts can be demonstrated is described. The A8W2 cell line derived from liver tissue of the African clawed toad, Xenopus laevis, was shown to be a favorable system for the quantitative study of photoreactivation in vertebrates. The uv irradiation was delivered with a high-pressure mercury lamp and photoreactivating light (PRL) was administered with a standard fluorescent desk lamp. Sixty-min exposure to PRL after either 50 or 100 erg/mm$^2$ of uv irradiation had a consistently salutory effect on the growth of A8W2. Cells that received 100 erg/mm$^2$ of uv plus PRL displayed a growth curve similar to that of cells receiving 50 erg/mm$^2$ of uv alone. Thus, PRL treatment caused a 50% reduction of the effective uv dose. PRL alone had no effect on cell growth. An experiment to test for photoprotection in this system, i.e., the effect of PRL before uv, showed no recovery of cell growth after 100 erg/mm$^2$ of uv irradiation. PRL treatment of 60 min after 75 erg/mm$^2$ of uv produced a marked increase in DNA synthesis. Incubation of uv-irradiated Hemophilus influenzae DNA in the light or in the dark with a homogenate of A8 cells resulted in restoration of transforming activity in the light which indicated the presence of photoreactivating enzyme in A8 cells. (BBB)

**45668** LESIONS OF THE PELVIS IN A 59-YEAR-OLD WOMAN. Dietrich, Donald E. (Duluth Clinic, Minn.). Minn. Med., 49: 1725-8(Nov. 1966).

The pertinent literature is reviewed and a case of postirradiation osteogenic sarcoma is described. The vulnerability of bone and cartilage to the effects of radiation are emphasized. Of almost 6000 patients previously reported, sarcomas developed in only two, giving an incidence of 0.3%, or 0.1% of the 2300 five yr cancer survivors. Thus, although radiation induction of bone sarcoma does occur in normal bone, it is a rare complication of radiation therapy for malignant disease. The present case is the fourth reported case following external beam therapy for cancer of the cervix. The ages of patients at the time of appearance of these iatrogenic sarcomas that have developed in normal bone or a benign bone lesion range from four to 68 yr, averaging 37 yr. Spontaneous osteogenic sarcomas, however, develop in a younger age group insomuch as almost half occur from 10 to 19 yr. The time from the last irradiation to the onset of clinically determinable sarcomatous change, the latent period, ranges from four to 30 yr, averaging 12, 8.6, 20, and 13.5 years in four recent large series. In general, the patients received large doses of low-energy radiation; a threshold dose of 3000 R with repeated exposure was reported. However, secondary malignant bone tumors may develop after small doses in children. Moreover, in most cases, skin changes and radiation damage to adjacent structures also occur. Gonadal dysfunction, soft tissue damage, disturbed bone growth, radiation osteitis, avascular necrosis, sequestration, and pathological fractures have been associated with this condition. In the case reported the tumor arose in normal bone that was in the field of irradiation. For an infiltrating anaplastic carcinoma of the cervix, x-ray therapy was administered at 200-KV for a daily exposure of 350 R in air over one of five pelvic fields (anterior, right and left posterior, and right and left lateral). The fields, that measured $10 \times 15$ cm, extended from the iliac crest to the pubic level. Thirty treatments were given with a total exposure dose of 2100 R in air to each field in 33 days. Subsequently, the patient developed an acute dermal reaction that was followed by severe scarring and telangiectasia. The sarcoma was discovered 10 yr later. (BBB)

**45669** EFFECT OF TELECOBALT IRRADIATION ON THE PRIMARY LESION OF CERVICAL CANCER. Kaneta, Ryoichi (Iwate Medical Univ., Japan). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 14: 189(July 1967).

The optimal therapeutic dose for carcinoma of the uterine cervix in telecobalt moving beam therapy was evaluated. In group A a tumor dose of 100 R was given daily (300 R was given every other day to point B of both sides with 200° pendulum ir-

radiation), and in group B a dose of 300 R was given daily to the cervix with 360° rotation therapy. The total tumor dose was 4000 R in group A, and in group B it was 6000 to 7500 R. Macroscopic and histological changes in the uterine cervix during and after irradiation were compared in the two groups. Macroscopically, the reduction of tumor size and appearance of ulcers and hemorrhages paralleled the total radiation dose. In both groups marked degeneration of the cancer cells was observed. In group A the proliferation of interstitial tissues was observed after irradiation with 2400 R and in group B after 3600 R. Proliferation of cancer cells was observed in $\frac{1}{3}$ of the cases of group A after 4000 R, but not in group B. Complete disappearance of the cancer cells was not recognized in any patient. Electron microscopically, vacuolization of the mitochondria and the endoplasmic reticulum in cancer cells was noted. In group A, these changes were observed after 3200 R, and in group B fragmentation of mitochondria and endoplasmic reticulum increased gradually after the end of the radiation therapy. Some cases showed an extremely favorable response for radiation therapy, but complete regression of cancer cells with the so-called canceroidal doses of 6000 and 7000 R was not always seen. The findings suggest that the pelvic lymph nodes cannot be given a sufficient dose by intracavitary irradiation. (BBB)

**45670** ADENOCARCINOMA OF THE ENDOMETRIUM: EVALUATION OF PREOPERATIVE IRRADIATION AND FACTORS INFLUENCING PROGNOSIS. Wade, Maclyn E.; Kohorn, Ernest I.; Morris, John McL. (Yale Univ., New Haven). Amer. J. Obstet. Gynecol., 99: 869-76(Nov. 15, 1967).

Complications of preoperative radiotherapy were evaluated in 265 patients with endometrial cancer, and the sensitization response (SR) and radiation response (RR) were determined for assessment of the prognosis in relation to therapy. In 92 patients in this series, satisfactory sensitization and radiation responses were obtained. That the SR was related to age was again confirmed. However, no relation of either SR or RR to prognosis could be found or to the persistence or absence of tumor in the irradiated uterus at the time of operation. The postirradiation excised uterus was examined histologically for the presence of tumor cells. Complications of therapy provide an objection to preoperative radiotherapy in that not only may there be more complications with operation following radiotherapy but also that radiotherapy itself can cause injuries. The radioinduced complications included two cases of cystitis, one of rectosigmoid stenosis, and one fatal case of coronary thrombosis. (BBB)

**45671** TREATMENT OF THYROTOXICOSIS WITH RADIOACTIVE IODINE. Greig, W. R. (Royal Infirmary, Glasgow). Scot. Med. J., 11: 307-14(Sept, 1966).

In their desire to conserve thyroid tissue, physicians often prescribed inadequate doses of $^{131}I$. About 30 to 40% of patients required multiple doses before their hyperthyroid symptoms were abolished. Nevertheless, since the hypothyroid incidence rates after short-term follow-ups varying from one to three yr were on the average 10 to 15%, this caution in dose seemed justified and there was no reason to suspect that the 80 to 90% of patients who were ultimately rendered euthyroid would not remain so. The relatively low hypothyroid rate after short-term follow-up was attributed simply to the immediate destruction of too many thyroid follicular cells; with prolonged follow-up the incidence of late hypothyroidism has risen steadily. The incidence rises linearly with length of follow-up and after intervals as long as 13 yr does not appear to level off. Postirradiation hypothyroidism is not due simply to excessive dosage within the range employed to control the overactive gland. The mechanism of the characteristically delayed onset of hypothyroidism is that of a delayed effect on surviving cells due to an immunological attack on the residual functioning thyroid cells. The specialized metabolic functions of thyroid cells (I trapping and thyroid hormone synthesis) are much more resistant to radiation injury than is their capacity to multiply. The results of $^{131}I$ treatment and x irradiation on thyroid function in rats are discussed, and it is concluded that postirradiation hypothyroidism would appear to be a consequence of thyroid cell sterilization. (BBB)

**45672** RESPONSE AND RECOVERY STUDIES ON X-IRRADIATED TRIBOLIUM CONFUSUM LARVAE. Yang, Chui-hsu. Urbana, Ill., Univ. of Illinois, 1967. 147p.

Thesis.

These studies were carried out to investigate the influence of exposure pattern, larval age, temperature, dose rate and other factors on the response and the degree and rate of recovery of x-irradiated larvae of Tribolium confusum. The general pattern of mortality was the same, when doses from 2.0 kR to 5.0 kR were used, for larvae of various ages from 2 days to 17 days, whether subsequently kept at 22°C or 30°C. There was very little mortality in the larval stage and a marked mortality between pupation and a time shortly after eclosion. Young larvae were less radiosensitive than old. Dose rate, in the range of 230 R/min. to 1250 R/min., showed no effect on the time-course of survival of irradiated larvae. Radiation lethality, however, was slightly increased with increase of dose rate. When larvae were kept at the lower temperature of 22°C after irradiation, or were exposed to 15°C for 24 hours prior to irradiation, survival was slightly decreased. No change in survival was observed when 14-day-old larvae were exposed to cycloheximide-flour-yeast medium for 4 days after irradiation. Larvae exposed to cycloheximide for 4 days before irradiation showed a radiosensitivity about the same as that of larvae before cycloheximide treatment, i.e., the lower sensitivity characteristic of younger larvae. A rapid recovery from radiation-induced damage was demonstrated in T. confusum larvae by means of the split-dose technique. Recovery reached a plateau around 6 hours after irradiation at 30°C, with a time to half-maximum recovery between one and two hours. No peak in the time course of recovery was observed consistently, and a first-order kinetics was generally followed. The rate of recovery was found to be higher in younger larvae. The maximum of recovery, however, appeared to be the same for all ages of larvae, about 0.8 to 0.9 kR when 2.5 kR was used as the conditioning dose. No significant effect of dose rate on the amount or rate of recovery was found, using dose rates in the range of 500 R/min. to 1250 R/min. Conditioning dose size did not affect the time to half-maximum recovery, but did affect the rate and amount of recovery significantly. Residual injury of irradiated 14-day-old larvae at 30°C with an interval 24 hours was found to be proportional to the $\frac{1}{4}$ power of conditioning dose. The possible relation between residual injury and chromosome rearrangement was discussed. Recovery showed a strong dependence on temperature. The time to half-maximum recovery was 1–2 hours, $2\frac{1}{2}$–3 hours, and 7–8 hours at 30°C, 22°C, and 15°C, respectively. The degree of recovery of larvae kept at 15°C for 48 hours between equally split doses of 4.0 kR was found to be 0.15 kR less than that at 22°C and 30°C with an interval of 24 hours. A definite decrease of the rate of recovery of larvae, exposed to cycloheximide before and during irradiation, was found. These results suggest that recovery requires metabolic processes and may involve protein synthesis. (Disser. Abstr.)

**45673** REPAIR OF DOMINANT LETHAL DAMAGE INDUCED BY X-RAYS IN IMMATURE OOCYTES OF DROSOPHILA MELANOGASTER. Traut, H.; Schmidt, P. (Univ., Muenster, Ger.). Int. J. Radiat. Biol., 13: 405-15(1967).

Immature oocytes of Drosophila melanogaster were exposed to increasing doses of 150 kV x rays, either continuously or by splitting the dose into two equal fractions separated by a time-interval of 1 hour (dose-rate 850 R/min). Survival was defined as the fraction of hatching eggs, the dominant lethal rate as one minus survival. Sigmoid survival curves were obtained both for the continuous and the fractionated treatment. All nine doses investigated yielded higher surviving fractions when applied in a fractionated instead of in a continuous manner. This was explained by repair (at a 'pre-lethal' stage) of a fraction F of the dominant lethal damage. F decreased with increasing dose. Dose protraction (e.g., 5 R/min) increased survival still more than dose fractionation did (under the special irradiation conditions of our experiments). A special mechanism of dominant-lethal induction after treatment of immature oocytes of Drosophila melanogaster with x rays was derived both from the dose-dependence and the dose-rate dependence of survival. (auth)

**45674** EXPERIMENTAL STUDIES ON ROLE OF SPLEEN IN RECOVERY FROM RADIATION INJURY IN MICE. II. EFFECT OF SPLENECTOMY ON HEMATOLOGICAL FINDINGS AND IRON METABOLISM IN MICE. Tanaka, Nobuo (Hiroshima Univ.). Hiroshima J. Med. Sci., 15: 325-46(Dec. 1966).

In the present study it was observed that the $^{59}Fe$ uptake by the erythrocyte and femur was increased in the splenectomized mice but its uptake in the liver was increased in the sham-operated mice four and 10 days after x irradiation. The result seems to indicate a disturbed utilization of $^{59}Fe$ by hemoglobin because of the depression of erythropoietic function. A similar recovery process was recognized also in the hematological findings of both splenectomized and sham-operated mice with x irradiation as described above. This fact seems to suggest that erythropoiesis of the mice after irradiation was accelerated by splenectomy. (NSA of Japan)

**45675** EXPERIMENTAL STUDIES ON ROLE OF SPLEEN IN RECOVERY FROM RADIATION INJURY IN MICE. III. EFFECT OF SPLENECTOMY ON SURVIVAL OF MICE WITH SPLEEN AND BONE MARROW TRANSPLANTATION FOLLOWING LETHAL X-IRRADIATION. Tanaka, Nobuo (Hiroshima Univ.). Hiroshima J. Med. Sci., 15: 347-68(Dec. 1966).

It was found that the secondary disease could be avoided by using injected marrow cells of the same strain as those of recipient animals. It was evident that only marrow cells from the same strain played a role in protection against late death. Also, it is of interest to note that the survival rates of the lethally irradiated mice transplanted with mixed bone marrow following splenectomy were higher than those of the sham-operated mice on the 60th day after irradiation, although no significant differences were found statistically. The results, seem to suggest that splenectomy of recipient animals would result only in some delay in the development of the secondary disease. (NSA of Japan)

**45676** RECEPTIVITY OF WHOLE-BODY IRRADIATED CHICKS TO PLASMODIUM GALLINACEUM. **Galli, L.; Brambilla, E.; Caprotti, M. (Univ., Pavia, Italy). Riv. Parassitol., 28: 165-72 (Sept. 1967). (In Italian).**

Three- and eight-day old chicks were exposed to different doses of x rays (200, 300, 450, 650, 750, 850 R) and then inoculated with Plasmodium gallinaceum (1,200,000 parasites per chick). Irradiation, at any dose, of three-day-old chicks resulted in an increase in the mortality at 24 hr. The severity of the infection increased according to the x-ray dose and death occurred at the time of high levels of infected red cells, while in the control animals death took place at the end of the parasitolytic crisis. Parasitemia occurred about five days earlier in the lethally (750-R) irradiated eight-day-old chicks than in nonirradiated controls, the mean survival times being 15.2 and 23 days, respectively, in the two groups. Lower doses (450 and 650 R) did not significantly affect mean survival time. (BBB)

**45677** CELL TURNOVER AND MAMMALIAN RADIOSENSITIVITY. **Patt, Harvey M. (Univ. of California, San Francisco). Cell Tissue Kinet., 1: 81-8 (Jan. 1968). (UCSF-10-P-2-34).**

Some basic facts of cell renewal relevant to radiation effects within a species and among species are reviewed. In analyzing the differential response of cell renewal systems to radiation, three factors were considered: the sensitivity of the component cells; the organization and control of the system as determinants of the rate of development of, and recovery from, the perturbed state; the significance of the system in the economy of the organism. A model cell renewal system was discussed. In general, cells that were maturing and no longer proliferating were relatively unaffected by doses of radiation sufficient to kill or otherwise block proliferating cells. This was true for maturing hemic and intestinal cells, and it applied to many, but not to all, functional cell types. Presumably, proliferating differentiating cells, i.e., those which did not function as stem cells, were about as sensitive as progenitor cells. Since cells differed in radiosensitivity at different stages of the proliferation cycle, possible changes in stage distribution, depending on whether the cell cycle was short or long, could influence the overall sensitivity of the population. The proliferation rate, i.e., the reciprocal of the cell cycle time, which differed for different cell types, could influence sensitivity in other ways as well, e.g., by affecting the development and repair of lesions. Factors contributing to the relative depletion of functional cells from an irradiated steady state population were discussed. (BBB)

**45678** LARVAL FORM AND VISCERAL SITUATION IN THE NEWT (TRITURUS ALPESTRIS) AFTER ONE-SIDED UV IRRADIATION OF NEURULAE AND POSTNEURULAE. **Kraft, Arne v. (Heiligenberg-Institut, Ger.). Arch. Entwicklungsmech. Organ., 160: 259-97 (Apr. 19, 1968). (In German).**

Neurulae and postneurulae of T. alpestris (up to Harrison stage 29) were irradiated with uv light from the left, right, dorsal, or ventral side. The duration of treatment ranged from 1 to 600 sec. Visible effects occurred even after a 5-sec irradiation. Embryos and larvae showed defects of histologic and gross external features. Inversions were distinguished from partial inversions. In inversions the curvature of the gut and the liver sinus (or in some cases, only the latter) were inverted. Partial inversions included instances of lesser expression. The frequency of total and partial inversions of the digestive system depended on the duration, stage, and side of irradiation. Irradiation of the left side led to a marked increase of partial inversions in all age classes. Increased total inversions occurred only after treatment in early stages with high doses. The frequency of experimentally elicited situs inversus viscerum decreased during neurulation. Inversions of the heart were less frequent than inversions of the gut. (BBB)

**45679** LASER BEAM. **Austr. Dent. J., 11: 197-8 (June 1966).**

Effects of laser radiation on tissues, particularly teeth, are briefly reviewed. The effect of laser impact on carious zones varied from holes several millimeters deep to complete disappearance of caries with some whitening of the surrounding rim of enamel. Large energy densities were required to produce changes in vitro in the enamel of normal teeth and greater destruction of the tooth substance followed when laser radiation was directed against discolored enamel. With laser radiation at 35 and 55 J on the lower incisors of Syrian hamsters, enamel destruction occurred to a greater or lesser extent depending upon the power output. Alteration of tooth structure was seen on the adjoining teeth and to a lesser degree on the maxillary incisors. The dental pulps showed severe change. In the coronal region there was hemorrhagic necrosis with inflammatory reaction. The odontoblasts suffered coagulation necrosis even as far posteriorly as the molar region, and vascularity of the pulp was increased. At 55-J irradiation the pulps of the mandibular molars also showed increased vascularity and degeneration of the odontoblasts. Inflammatory reaction was also noted in the periodontal and gingival tissues of the lower incisal region. (BBB)

**45680** X-RAY CATARACT. **Gruetzner, P. (Univ., Heidelberg). Klin. Monatsbl. Augenheilk., 149: 243-5 (1966). (In German).**

The development of cataracts in a 50-yr old woman who was exposed for about 200 hr to scattered x irradiation while working in a mail office 16 yr previously was described. Her primary duties included examination of foreign mail with chemicals and uv lamps. For ½ to one hr periods two or three times a week over a period of one yr letters were examined with x-ray equipment, without any protective clothing. No symptoms from the irradiation received were noted during the period of exposure. The type of x-ray equipment and the exact dose could not be calculated. Since lens opacities are known to be caused in humans by a dose of 500 R it was probable that this dose was exceeded in this case. It was speculated that some cataracts reported to be of unknown genesis may have resulted similarly from accidental irradiation. (BBB)

**45681** EFFECTS OF DIFFERENT TYPES OF RADIATION ON VARIOUS LIFE STAGES OF CEREAL LEAF BEETLE, OULEMA MELANOPUS (LINNAEUS). **Brennan, Patrick Anthony. East Lansing, Mich., Michigan State Univ., 1967. 125p. Thesis.**

Eggs, larvae and pupae were exposed to varying levels of $\beta$ radiation. Observations were carried out to determine the effects of exposure on hatching, larval development, pupation and eventual adult emergence. In addition, pre-diapause adults were irradiated with $\beta$, $\gamma$, and x rays. Following a period of cold treatment to terminate diapause, a series of tests were initiated to determine levels of induced sterility, effects on mating, feeding and longevity of both irradiated males and females at the different treatment levels. Effects on mating and induced sterility were established by pairing irradiated males with untreated females. On the basis of the sterility and mating data, mixing tests were set up in which irradiated males were mixed with untreated males at ratios of 5:5 and 9:1 and paired with untreated females. Percentage hatch of eggs produced in these mixing tests was observed and the reduction as compared with untreated male–untreated female matings was determined. In a further series of mixing tests the untreated male was marked and his relative participation in mating determined. From these mixing tests with marked untreated males and the mating counts recorded for irradiated male–untreated female pairings it was possible to estimate the reduction in competitiveness resulting from exposure to each of the three types of radiation. (Diss. Abstr.)

**45682** X-RAY-INDUCED CHANGES IN THE CELL BODY OF AMOEBA. **Chatterjee, S. (Presidency Coll., Calcutta). Z. Biol., 116: 68-80 (Feb. 1963).**

The soil amoeba Acanthamoeba sp. was irradiated with x rays at doses ranging from 50 to 200,000 rad. The irradiated amoebae were reared for ten subcultures for study of cytomorphological changes. The initial effects consisted of an increase of cellular and nuclear volume, an increased rate of locomotion at lower doses, a decreased rate or temporary cessation of locomotion at higher doses, hypervacuolization, a slower rate of contractile vacuolar output, and nuclear extrusion. A decreased rate of mitosis in irradiated amoebae was observed at all doses. Mitotic delay often resulted from incomplete cytokinesis and persisted up to the second subculture. Three kinds of radioinduced cellular death were encountered: death after mitotic division, death before mitotic division, and death by cytoplasmic fragmentation. Various kinds of discrete bodies were produced in third subculture in amoebae irradiated with different doses. They were spherical, rod-shaped, or sausage-shaped bodies which persisted up to 5th subculture in some instances. An enhanced secretory activity was noted in amoebae, particularly at third subculture. The exudation

product was metachromatic. The x-radioinduced changes in amoebae were transient in nature. The visible effects of changes manifested in one subculture may continue at a reduced frequency in the next one or two subcultures, then fail to appear in subsequent generations. In general, two kinds of changes were seen in amoebae after irradiation; first, inhibitory effects suppressing the vital activity; second, stimulation of synthetic activities in inducing new formation in the cell. (BBB)

**45683** INVESTIGATIONS ON THE RADIOACTIVITY OF ROCKS IN CONNECTION WITH THEIR POSSIBLE INFLUENCE ON THE DEVELOPMENT OF PNEUMOCONIOSIS. Sklyarenko, I. P.; Enyakova, P. A.; Krigman, F. E.; Krivitskii, M. D.; Kolesnik, A. P.; Tsapuk, A. K. Gig. Tr. Prof. Zabol., 8: 13-19 (Apr. 1964). (In Russian).

Various coals and rocks occurring in the Donetsk basin were studied on the basis of their radioactivity and possible relation between this and the development of pneumoconiosis. Exploration and inspection were also made of mines and coal beds with varying modes of occurrence and wide range of metamorphic changes. The radiometric analysis included measurements of specific rock activity, separately for $\alpha$, $\beta$, and $\gamma$ radiation. Tests were made involving dust inhalation of experimental animals with dust samples of different radioactivity. Evidence was gained that the analyzed rock samples possessed natural radioactivity exceeding the average value for the whole of the earth crust. Most of the coal samples (excepting those presenting elevated ash content) were devoid of radioactivity. Exposure of animals in a dust chamber with aleurolite dust samples of different natural radioactivity failed to produce any distinctions in the pathohistological picture of the lungs. Several kinds of the aleurolite dust provoked a qualitatively similar reaction common to the morphological picture of silicosis. Intratracheal administration of coal dust to lab animals (in one of the dust samples used radioactivity was absent, while in the other it amounted to 400 cpm/g of $\alpha$ radiation) produced a slowly progressive focal fibrosis typical of experimental anthracosis. No differences in the character, rate of development, and morphological reaction of the pulmonary tissue in experimental animals were demonstrated in these tests. (BBB)

**45684** THE EFFECT OF AGE, STRAIN, AND EXPOSURE INTENSITY ON THE MORTALITY RESPONSE OF NEUTRON-IRRADIATED MICE. Hightower, Dan; Woodward, Kent T.; McLaughlin, Mary M.; Hahn, Fletcher F. (Walter Reed Army Medical Center, Washington, D. C.). Radiat. Res., 35: 369-77 (1968).

Mice from three strains (ICR, C57Bl/6J, and Bagg-Swiss) were exposed to neutrons at 6, 8, 12, or 16 weeks of age. Strain, as well as age, was found to influence the radiation response as measured by median lethal dose and survival time. ICR strain mice were irradiated under similar conditions at dose rates of 1, 10, 50, 100, or 200 rads/min or a pulse of radiation. There was no demonstrable effect of exposure intensity on median lethal dose or on survival time. (auth)

**45685** MAJOR MALFORMATIONS IN TROUT EMBRYOS IRRADIATED PRIOR TO ACTIVE ORGANOGENESIS. McGregor, John F.; Newcombe, Howard B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Res., 35: 282-300(1968).

Frequencies of major malformations of the eyes and the bodies of trout embryos (Salmo gardneri) were studied following exposures of embryos to 10, 100, and 1000 rads of x rays at early cleavage, late cleavage, blastula, and germ ring stages. A sham-irradiated control was carried out for each stage of irradiation. Contrary to evidence from mammalian studies, embryos of trout developed a high incidence of major malformations when irradiated prior to active organogenesis, there being a peak effect of 40% eye malformations and 35% body malformations at late cleavage. The apparent lack of quantitatively similar responses in mammals was thought to be due to loss of potentially malformed individuals to study through selective failures to implant or through postimplantation deaths. A curious finding was that the various kinds of malformations were apparently identical to those previously observed as a consequence of irradiations of sperm and eggs. Thus, the same vulnerable processes must be upset in similar ways both by exposures of the embryos to external agents such as radiations and by influences that were essentially internal to the embryos such as the altered hereditary material transmitted from irradiated sperm or eggs. (auth)

**45686** RELATIONSHIP BETWEEN ANIMAL AND STEM CELL DOSE-SURVIVAL CURVES. Robinson, C. V. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 35: 318-34 (1968). (BNL-11963).

A model of acute mammalian hemopoietic radiation mortality is proposed that relates the dose-survival curve of a population of animals with that of its stem cells. An animal is assumed to survive if it has a certain threshold number of effective mature cells, given by a threshold function, at a specified time after irradiation. A random variable, the effective proliferation factor, is specified, which describes the proliferation initiated per stem cell. With the assumption that stem cell survival obeys Poisson statistics, the probability that an animal will survive a dose, D, is then uniquely determined. This probability is found to give an approximately normal, S-shaped dose-survival curve, the mean dose and width of which are known functions of six stem-cell parameters and five additional parameters. The width of the curve depended principally on: interanimal variation of radioresistance (in turn dependent on the interanimal variations of five parameters); and randomness in the number of stem cells surviving, and in the effective proliferation per stem cell. A principal conclusion was that the steepness of the animal dose-survival curve set an upper limit on the possible values of the interanimal variation of the stem-cell inverse slope parameter, $D_0$. The theory was applied to the mouse as a numerical example. (auth)

**45687** CIRCULATORY RESPONSE TO A SUPRALETHAL EXPOSURE OF WHOLE-BODY X-IRRADIATION IN DOGS. Liu, C. T.; Overman, R. R. (Univ. of Tennessee, Memphis). Radiat. Res., 35: 335-40(1968).

Cardiovascular hemodynamic changes were measured 48 hours following a supralethal exposure (1500 R) of whole-body x-irradiation in dogs. It was found that the stroke volume and the femoral blood flow were decreased, and the heart rate and the femoral fascular resistance were increased without altering the total peripheral resistance. No significant change was observed in blood pressure, cardiac output, electrocardiogram, mean circulation time, hematocrit, plasma volume, blood volume, circulating red cell volume, and central blood volume. The results indicate that these functions of the circulatory system were well-maintained through compensatory mechanisms approximately 24 hours before death as a result of severe radiation injuries. (auth)

**45688** TRANSPLANTATION OF HETEROLOGOUS TISSUE AS A MEANS OF RESTORING AXOLOTL LIMB REGENERABILITY AFTER DEPRESSION BY X-IRRADIATION. Polezhaev, L. V.; Tuchkova, S. Ya. Dokl. Akad. Nauk SSSR, 180: 754-7 (May 21, 1968). (In Russian).

The rear limbs of 100 axolotls (Amblystoma mexicanum), 10 months old, 10 to 15 cm long, were x-irradiated to 800 R and amputated after 20 to 30 days and again after 100 days. In some animals, rat or frog muscle tissue was implanted on one side after 10 to 14 days. Statistical treatment of the data showed, in some cases, a definite improvement in regeneration capability as a result of the transplant. However, the effect was not observed in all cases, and further work is needed to determine why the effect was not 100%. The results are discussed in relation to the roles of protein and RNA in the restoration. (TTT)

**45689** ON THE INCREASED EXCRETION OF TAURINE AND BETA-AMINOISOBUTYRIC ACID IN URINE FOLLOWING IRRADIATION AND THE SENSITIVITY OF THESE BIOCHEMICAL REACTIONS; ON THE ORIGIN OF THE INCREASED TAURINE EXCRETION IN IRRADIATED RATS. I. DISCUSSION CONTRIBUTION. Melching, Hans-Joachim (Univ., Freiburg i. B.). Strahlenschutz Forsch. Prax., 4: 231-3(1964). (In German).

The results of a study relating taurine excretion to whole-body doses of x irradiation of 2.5, 5, 10, 50, 100, 400, and 690 R in mice are reported. Up to a dose of 50 R no differences in taurine excretion were observed, as compared to control animals. These studies emphasized the need to compare measurements of taurine in irradiated animals with control animals for exactly the same day and the same time of day, because the taurine excretion in the unirradiated control animals varied widely from day to day. There is no explanation available for this, but it does not negate the value of taurine excretion as a diagnostic measure of radiation injury, because in practice several measurements are necessary to establish a diagnosis. For interpretation of the taurine excretion curve after irradiation, particular attention should be paid to the fact that during the first two weeks after irradiation the initial increased excretion of taurine that occurs immediately after irradiation is followed by a time interval when taurine excretion is somewhat lower than normal values. Further studies are necessary in order to establish the significance of these two differences in the chronological excretion of taurine after irradiation. (BBB)

**45690** EXPERIMENTAL STUDIES ON CONTACT ECZEMA. IV. DESENSITIZATION EXPERIMENTS ON THE DERMIS AND EPIDERMIS OF 2,4-DINITROCHLOROBENZENE-SENSITIZED GUINEA PIGS. Klaschka, F. (Freie Univ., Berlin). Arch. Klin. Exp. Dermatol., 228: 91-110(Feb. 2, 1967). (In German).

In guinea pigs sensitized to dinitrochlorobenzene (DNCB), desensitization was studied by injections of different DNCB conjugates, injections of the hapten (DNCB), and after x irradiation.

The patch tests, excised before and after hyposensitizing treatment, were investigated histologically. Subcutaneous injections of guinea pig serum-DNB conjugates inhibited immediate, but not delayed reactions. The contact reactions showed intense granulodiapedesis and granuloclasia, interpreted as the result of the preceding perivascular antigen-antibody reactions. Extracts of guinea pig epidermis-DNB conjugates, injected subcutaneously and intraperitoneally, reduced the patch test reactions to a higher degree than equivalent serum-DNB conjugates, particularly in epicutaneously DNCB-sensitized animals. Even high doses of epidermal DNB conjugates did not totally inhibit the reaction. Intravenous injections of high doses of DNCB dissolved in Tween 80, or with erythrocytes, reduced or inhibited patch test reactivity regularly, but only temporarily. After 300-R whole-body irradiation the degree of contact dermatitis reactions in the guinea pigs decreased to a minimum, in parallel with the number of lymphocytes in the blood. The patch test reactions at this stage resembled macroscopically and histologically the urticarial reactions. They were interpreted as reactions to antibodies that were simultaneously present. (BBB)

**45691** MATERIALY O BIOLOGICHESKOI ROLI KOSTNOGO MOZGA PRI OSTROI LUCHEVOI BOLEZNI. (Reports on Biological Role of the Recticular Cells of the Marrow During an Acute Radiation Sickness). Gol'dberg, E. D. Tomsk, USSR, Publishing House of the Tomsk Univ., 1967. 94p.

Hematological problems during an acute radiation sickness induced by irradiation from various energy accelerators--betatrons are discussed. Data obtained from various experiments concerning reactions of the recticular marrow cells following total irradiation of animals are evaluated. The first chapter of the book describes the characteristics of the bone marrow in a healthy guinea pig, the second chapter is devoted to the origin and properties of gigantic neutrophils, and the third chapter handles the problems of the nature of the Kurlov body. (R.V.J.)

**45692** GROWTH AND LIFE-SPAN OF MICE IRRADIATED AT THE LOW DOSE RATE. Ueno, Yori; Kano, Eiichi (Kyoto Univ.). Jap. J. Aerosp. Med. Psychol., 4: 38-43(June 1967). (In Japanese).

The life-span, the incidence of chest tumor and body weight of C3H female mice irradiated at the low dose rate of 50 R/5 w (1.43 R/day) till the death of all mice, were observed. The life-span of irradiated mice was reduced to 78% of control. The percent survival was reduced and the mortality rate per day was higher in the irradiated group than in the control group. No effect on the incidence of chest tumor by irradiation and on its latent time, was observed. The body weight was smaller in the irradiated group than the control and did not increase after exposure of accumulated dose 250 R in the former, while it increased in the latter (correspondent to accumulated dose 1,000 R). In consideration of a long trip in space, an experiment for long term effects at a low dose rate of less than 0.1 R/day on mammals should be undertaken in the future. (auth)

**45693** REMOTE SEQUELAE FOLLOWING INJURIES INFLICTED BY $^{131}I$. Strel'tsova, V. N.; Moskalev, Yu. I. Med. Radiol., 13: No. 6, 17-28(June 1968). (In Russian).

Late effects of $^{131}I$ incorporation were studied. $^{131}I$ was introduced to female rats of the Wistar lineage per os at one time in amounts of 7.8; 15.6; 31.2; 62.2; 120; 240; 480 $\mu$Ci per rat. Animals that lived for more than 200 days developed benign and malignant tumors of the thyroid gland, adrenal cortex, ovaries, and mammary glands, and benign new growths of the hypophysis. They also demonstrated the presence of dyshormonal mammary gland proliferates (mastopathy), uterine proliferates (polyps, glandular hyperplasia of mucosia, etc.), hormonally active and serous ovarian cysts. The development of $^{131}I$-induced tumors of the thyroid and hypophysis differs genetically. New growths of the thyroid develop as the result of direct action of radiation, whereas tumors of the hypophysis and also of other internal secretion glands as well as of organs controlled by them owe their appearance to the working of the dyshormonal mechanism. In the chronic stage of the lesion some animals-carriers of $^{131}I$ develop vascular nephrosclerosis. (auth)

**45694** INFLUENCE OF ENTERAL VACCINATION OF THE RADIORESISTANCE OF MICE. Murav'eva, L. I. Byull. Eksp. Biol. Med., 65: No. 5, 44-6(May 1968). (In Russian).

The author studied the influence of enteral vaccination with a heat killed culture of Salmonella breslau on the radioresistance of mice. Mice received the vaccine once (10 billion) and several times 1 to 2 hours, 1, 4, 7, 15, and 20 days prior to irradiation x rays—550 R, gamma rays—725 R) and after irradiation—30 minutes, 1, 5, and 10 days. In some experiments the survival of experimental mice exceeded the control group by 10 to 80%. The best results after vaccination were obtained when vaccination was made 4 and 7 days prior to irradiation. (auth)

**45695** ONTOGENETIC DEPENDENCE OF THE INTERRENAL GLAND REACTION ON IRRADIATION. Tkacheva, G. A. (Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med., 65: No. 5, 109-13(May 1968). (In Russian).

Histological and histochemical studies of reaction of the interrenal gland of anuran amphibia in different periods of ontogenesis were carried out (larvae during the stage of premetamorphosis, at the height of metamorphosis, intermediate and adult forms) after irradiation with 10,000, 5000, 1500, and 700 R. The interrenal gland begins to function at the time of its morphological formation, at the beginning of metamorphosis. Radioresistance of amphibia decreases proportionally to the ontogenetic complication of their organization. This is caused by increased radiosensitivity of the cortical elements of the interrenal gland. (auth)

**45696** EFFECT OF X RAYS ON THE OVARY OF THE HEN AND ON OVULATION. Brard, Emile (Coll. de France, Paris). Compt. Rend., Ser. D, 266: 1996-9(May 6, 1968). (In French).

X rays induce the destruction of a significant number of ovarian follicles without, however, reducing the frequency of egg laying of the irradiated hen. The eggs laid can be fertilized and hatch apparently normal chickens. X-ray doses of 600 R/week arrest ovulation only at the beginning or the end of the annual sexual cycle of the hen. (tr-auth)

**45697** THE EFFECT OF 1200 R OF X RADIATION ON DENTINOGENESIS IN THE MANDIBULAR TEETH OF RATS. Adkins, K. F. (Univ. of Queensland, Brisbane). Arch. Oral Biol., 12: 1569-76(1967).

The effects produced by 1200-R x irradiation on the development of dentin in the incisor teeth of rats was studied in 3 groups: 1200 R applied to the head as a single dose on day 32 of life, 1200 R in 2 doses of 600 R on days 29 and 32, and 1200 R in 4 doses of 300 R on days 29, 30, 31, and 32. The animals were killed 1 to 28 days following the completion of irradiation and the dental histology. Rapid development of edematous spaces, formation of precisely defined dentin niches, degeneration of odontoblasts, differentiation of pulpal mesenchymal cells into osteoblasts, and the production of coarse osteodentin were apparent in all irradiated incisors irrespective of the dose/time pattern used. Fractionation of the total dose into $2 \times 600$ R and $4 \times 300$ R did not significantly reduce the deleterious effects which the single large dose had on the development of dentin. The demarcation of the osteodentin from the tubular dentin both anteriorly and posteriorly to it was always quite sharp so that the interval during which the odontoblasts were radiosensitive was precise. Odontoblasts anterior to this region and those formed subsequently appeared unaffected by irradiation and the dentin matrix adjacent to them was structurally normal. (BBB)

**45698** EARLY CHANGES IN THE PERIPHERAL BLOOD FOLLOWING EXPOSURE TO BORDER-LINE RAYS. Murzenko, D. I. Med. Radiol., 13: No. 6, 87-9(June 1968). (In Russian).

By setting up experiments on 50 albino mice and observing 50 patients suffering from dermatoses, it was observed that modifications in the peripheral blood occurring after exposure to border-line rays in doses of from 10 to 1000 R set on very quickly following irradiation. There became apparent only early alterations in the white blood cells in the form of a rapid succession of two phases of leucocytosis at the 5th and 30th min, with subsequent decline at the 15th and 60th min. Then, for a space of 3 to 5 days there was an insignificant leucocytosis, due to the prevalence of lymphocytes. Fluctuations of the blood leucocytes count in patients with various dermatoses continued throughout the entire course of treatment with border-line rays, but did not exceed the bounds of the physiologically normal level, except for the first few hours. (auth)

**45699** ROLE OF SUNLIGHT IN CUTANEOUS CARCINOGENESIS IN MAN. Giordano, Giovan Giacomo (Tumori Fondazione Senatore Pascale, Naples). Tumori, 54: 81-92(Jan.-Feb. 1968). (In Italian).

The effects and mechanism of action of uv radiation on skin are reviewed, along with clinical and experimental information on atmospheric and individual factors in skin carcinogenesis by sunlight. Cases studied indicated that the highest incidence of skin tumors occurred in the areas that are exposed and in subjects working in the open air. Thus, in 4123 cutaneous carcinomas observed between 1938 and 1966, 3973 (or 96.36%) were present in exposed areas, i.e., face, neck, or hands. The remaining 150 cases involved partially exposed region and the remaining 82, nonexposed skin. A total of 2029 (49.22%) of the skin cancers occurred in persons working outdoors especially as farmers. It was suggested that both carcinogenic and noncarcinogenic photo-

dynamic chemical agents may have a role in cutaneous carcinogenesis, stimulation occurring at a wavelength higher than the uv range. (BBB)

**45700** HISTOPATHOLOGY OF ACTINIC CHEILITIS. Koten, J. W. (Royal Tropical Inst., Amsterdam); Verhagen, A. R. H. B.; Frank, G. L. Dermatologica, 135: 465-71(1967).

Histopathologic characteristics of chronic lesions of the lip induced by solar uv radiation are described with reference to 15 cases in Africans. In all 10 cases in which ulceration was seen, the ulcer was shallow, with loss of epithelium and little or no defect in the underlying tissue. The base of the ulcer was covered with an exudate of fibrin and polymorphonuclear leucocytes. Melanin pigment was absent from the atrophic areas of the epidermis. In no case was there any evidence of nuclear atypia, abnormal mitotic activity, or disorders of maturation of epidermal cells as is seen in leukoplakia. The most characteristic feature of the lesion was in the dermis, where a band-like infiltrate was present under the ulcer and adjacent atrophic epidermis. This band was of varying thickness, and in some cases extended through the dermis into the superficial portions of the fatty tissue in the subcutis. A constant feature was the presence of this infiltrate of large numbers of plasma cells. In all cases, blood vessel changes were prominent, consisting of a generalized dilatation of all vessels (arterioles, capillaries, and venules) with swelling and prominence of the endothelial cells. Proliferation of endothelial cells was not seen. Thus the characteristic histological pattern of actinic cheilitis includes epidermal atrophy and depigmentation, often associated with very superficial ulceration, and accompanied by a dense, band-like inflammatory infiltrate in which plasma cells predominate, and with prominent vascular dilatation. (BBB)

**45701** USE OF THE MOHS' CHEMOSURGERY TECHNIQUE IN THE TREATMENT OF SKIN CANCERS. Phelan, John T.; Milgrom, Halina (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 125: 549-60(Sept. 1967).

Application of the Mohs' chemosurgery technique for treatment of patients with skin cancer caused by irradiation is described. Technically, the procedure differs from conventional surgical excision in that the excision is microscopically controlled. This control is accomplished by fixation of the tumor in situ with zinc chloride paste and later excision of the fixed tissue in a systematic fashion. The Mohs' chemosurgery technique was found to be particularly applicable for cutaneous cancers of the cheek. It proved most effective in managing cancers that originated in areas of radiodermatitis. (BBB) (TSS)

**45702** ESTIMATION OF PULMONARY BLOOD FLOW BY $^{131}$I-MAA PULMOGRAM WITH SPECIAL REFERENCE TO PULMONARY CARCINOMA BEFORE AND AFTER RADIOTHERAPY. Oyamada, Hiyoshimaru; Yoneyama, Takeshi; Sakura, Mizuyoshi; Tsuboi, Eitaka; Atsumi, Kyoko (National Cancer Center, Tokyo). Tohoku J. Exp. Med., 93: 79-91(Sept. 1967).

The effect 6 MeV linear accelerator therapy (doses of 3800 to 10,000 rad) on pulmonary blood flow was studied in 13 cases of lung cancer studied by use of macroaggregated serum albumin-$^{131}$I ($^{131}$I-MAA). Out of nine cases of hilar type, five cases (three anaplastic cell carcinomas, one squamous cell carcinoma, and one adenocarcinoma) showed a definite increase in the pulmonary blood supply on the $^{131}$I-MAA pulmogram after the radiotherapy. In the above-mentioned five cases, three (one anaplastic cell carcinoma, one squamous cell carcinoma, and one adenocarcinoma) showed almost a complete return of normal pulmonary blood flow. The remaining four cases (two the anaplastic cell carcinomas, and two squamous cell carcinomas) did not show any improvement on the $^{131}$I-MAA pulmogram. In all four cases of peripheral type, no increase in the pulmonary blood supply was recognized on the $^{131}$I-MAA pulmogram upon completion of radiotherapy. One case of adenocarcinoma and one case of squamous cell carcinoma showed a marked decrease in pulmonary blood flow even though x-ray findings revealed a good response to the radiotherapy. This may be due to pneumonitis or fibrosis induced by irradiation. (BBB)

**45703** URANIUM MINING AND LUNG CANCER. Cooper, W. Clark (Univ. of California, Berkeley). J. Occup. Med., 10: 82-8(Feb. 1968).

Evidence for the carcinogenic effect of U in the lungs of miners is reviewed. The underground mining of U is associated with an increased incidence of lung cancer, characterized by predominance of undifferentiated cell types, a younger-than-average patient age, and a rapidly fatal course. Radon and its daughter products are probably major etiologic factors, based on the general correlation between cumulative exposure and incidence, existence of increased cancer rates in other mining groups with proven or probable Rn daughter exposures, and the failure to demonstrate any other common causative factor. Quantitative definition of the dose-response relation is impossible, as the number of individuals and periods of observation at low exposure levels are now inadequate. Both threshold and nonthreshold components may be involved, with respect to both the radiation hazard and certain co-factors. Actual induction is probably nonthreshold, with linearity affected by threshold phenomena relating to clearance of particles prior to induction, and by other threshold phenomena relating to the appearance of latent tumors. Practical measures for controlling environmental exposures and surveillance are considered. (BBB)

**45704** ON THE INCREASED EXCRETION OF TAURINE AND BETA-AMINOISOBUTYRIC ACID IN URINE FOLLOWING IRRADIATION AND THE SENSITIVITY OF THESE BIOCHEMICAL REACTIONS; ON THE ORIGIN OF THE INCREASED TAURINE EXCRETION IN IRRADIATED RATS. II. DISCUSSION CONTRIBUTION. Ritzl, Friedrich. Strahlenschutz Forsch. Prax., 4: 234-5(1964). (In German).

Results of studies of the incorporation of $^{3}$H-labeled thymidine by bronchial carcinomas in patients are reported. In histological sections obtained after administration of the $^{3}$H the greatest concentrations of $^{3}$H were found in the tumor and its metastases, and in the liver. In other patients it was found, by chromatographic studies after radiotherapy and administration of the $^{3}$H, that radioactive $\beta$-aminoisobutyric acid was excreted in the urine. In addition to these studies, in other patients, six days after the $^{3}$H administration tumors were irradiated with a dose of 10 R, followed three days later by 50 R, six days later by 100 R, and 15 days later by daily doses of 200 R of $^{137}$Cs irradiation. There was no evidence of increased urinary excretion of radioactivity in the patients who received less than 200 R irradiation. The differences observed in the soses of irradiation required to produce $\beta$-aminoisobutyric acid excretion in bronchial carcinoma patients and in patients with chronic leukemia and lymphogranulomatoses are ascribed to differences in tumor radiosensitivity. Fractionated irradiation doses that produced excretion of $\beta$-aminoisobutyric acid in normal subjects were high because tissues, such as bone marrow, that are not very radiosensitive are irradiated. (BBB)

**45705** OMENTOPEXY WITH HYSTERECTOMY AFTER HEAVY IRRADIATION. Graham, John; Goplerud, Dean (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 125: 1232-8(Dec. 1967).

Radical hysterectomy performed after a full course of radiotherapy is dangerous. Previous irradiation impairs healing of the exposed area because of ischemia and diminished cellular vitality. Three factors that influence the risk of complications are the amount of radiation, type of operation, and time interval between. The usual dose for cervical cancer is 7000 to 8500 R at point A, including both Ra and x-ray therapy in 5 to 6 weeks. Large doses of external therapy make an operation more hazardous than does intracavitary or interstitial Ra treatment. Up to six weeks after irradiation there is no evidence of ischemia and healing is relatively unimpaired; however, beyond that time, the tissues are progressively less vigorous. Radical hysterectomy and heavy doses of radiotherapy are incompatible if widely spaced in time. For the patient treated initially with radiotherapy for persistent or recurrent cancer that manifests itself many months or years later, radical surgery is excessively dangerous. Reirradiation is equally hazardous and rarely controls the cancer. Exenteration is modestly effective but the cost in terms of functional loss is very high. In patients with recurrent cancer the fistula can be closed and will heal if nonirradiated tissue, such as muscle or omentum, is used to cover the suture line. (BBB)

**45706** DYNAMICS OF PHAGOCYTIC FUNCTION OF THE RES IN THE WHOLE-BODY IRRADIATED RATS. Antonijevic, Milos (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Strahlentherapie, 135: 708-13(June 1968).

A study of phagocytic function of the reticulo-endothelial system was undertaken in irradiated rats following intravenous injection of colloidal carbon suspension. Rats were exposed to the following doses: 100, 200, 300, 600, 800, 1000, and 1200 R. Phagocytic function was tested on the 1st, 2nd, 4th, and 10th day after irradiation. Results showed that the phagocytic activity was increased after all the administered doses of irradiation. Global phagocytic index was higher in comparison with control values for nearly all days of observation, but it was remarkably elevated on the 10th day. Increased phagocytic activity in irradiated organism is considered to be a defense reaction. (auth)

**45707** INVESTIGATION ON COMBINATION INJURIES. PART 8. CHANGES IN WHITE AND RED BLOOD CELLS OF RATS AFTER WHOLE-BODY IRRADIATION IN COMBINATION WITH OPEN SKIN WOUNDS. Messerschmidt, Otfried; Birkenmayer, Eline; Koslowski, Leo (Univ., Freiburg i. B.). Strahlentherapie, 135: 586-96(May 1968). (In German).

After a whole-body x irradiation of rats (640 R) with open skin wounds on their back, examination of the peripheral blood showed that the number of granulocytes and lymphocytes fell in the same way as after irradiation alone. During the recovery period there was a more pronounced recuperation of the lymphocytes and of the granulocytes than after irradiation only. The erythrocytes showed also a more marked alteration than after irradiation alone. The possible causes of this severe anemia are discussed. (auth)

**45708** THE INFLUENCE OF COMPENSATORY HYPERTROPIC GROWTH ON IRRADIATION NEPHRITIS OF RATS. Bargon, Gerlach; Moench, Helga (Univ., Goettingen, Ger.). Strahlentherapie, 135: 565-74(May 1968). (In German).

In 260 male Wistar rats, the effect of renal x irradiation with 3000 R was compared on intact animals and after unilateral nephrectomy. The radiobiologic effect was studied by determining dry weight and water content of the kidneys, and by evaluating the morphologic alterations. The results show that radiosensitivity of the kidney was lowered by the compensating and higher functional activity following nephrectomy. This function enhancement was attributable to an important epithelial regeneration activity, often even pathologic, of the tubules. Although it is now generally accepted that a radiation lesion of the kidney is not more pronounced after unilateral nephrectomy, the loss of renal parenchyma cannot be compensated by an irradiated kidney. The loss of one kidney and irradiation of the remaining kidney is a severe stress for the individual. (auth)

**45709** EFFECTS OF CORTICOID ON SURVIVAL OF (IRRADIATED) ANIMALS TREATED WITH SUPERLETHAL DOSES. Zseboek, Zoltan B.; Baumgartner, Edit; Janossy, Gyoergy (Medizinisch-Radiologische Forschungsinstitut, Budapest). Strahlentherapie, 135: 623-7(May 1968). (In German).

Experience has shown that the absence of glucocorticoid secretion is the primary cause of the early death of adrenalectomized rats, after x irradiation with supralethal doses (1300 R). Contrary to what could be expected, substitution and treatment with spirolactone demonstrated that the absence of mineralocorticoid secretion has no influence on the survival of irradiated animals with the gastrointestinal syndrome. Cortisone however was shown to have a beneficial effect, not only on the adrenalectomized animals, but also on the irradiated animals with normal adrenals. (auth)

**45710** MECHANISM OF POSTNATAL CHANGES OF FOLLICLES BY INTRAUTERINE IRRADIATION OF OVARIES WITH SMALL DOSE. Vorisek, Premysl; Vondracek, Jiri (Anstalt fuer Muetter- und Kinderfuersorge, Prague. Mathematische Institut, Prague). Strahlentherapie, 135: 602-9(May 1968). (In German).

Differential counting of the follicles (primary, secondary, and vesicular) was used to evaluate the mechanism of radiation injury in the ovary of the rat after continuous intrauterine exposure to $^{60}Co$ $\gamma$ (2.5 R/24 hrs, total dose 50 R). The modifications were studied in animals aged 25, 60, and 120 days. The number of primary follicles was significantly reduced at all ages. Hence it was concluded that the first lesion is a disturbance of the prepubertal oogenesis. In the animals aged 25 days, a significant depression was found for all types of follicles. Only the primary follicles were reduced in animals aged 60 days. For animals aged 120 days, a significant reduction of the number of primary and secondary follicles was observed. (auth)

**45711** REPOPULATION OF THE BONE-MARROW STEM-CELL COMPARTMENT AFTER IRRADIATION. Silini, G.; Elli, R.; Siracusa, G.; Pozzi, L. V. (CNEN, Rome). Cell Tissue Kinet., 1: 111-22(Apr. 1968).

Bone-marrow repopulation was followed as a function of time after a single whole-body dose of 150 rads x rays to (C3H × C57Bl) $F_1$ hybrid mice. The number of nucleated cells per bone shaft was estimated by direct counting and the number of progenitor cells by the exogenous spleen-colony assay method. Vinblastine was also administered under various schedules of time and dose to distinguish between cycling and dormant cells in the progenitor pool. The depopulation of total marrow cells induced by Vinblastine proceeds at a comparable rate in irradiated and in normal mice. On the other hand, the depopulation of the colony-formers is faster in irradiated than in normal animals. The data are interpreted to show that the fraction of cycling progenitor cells is larger in a hemopoietic tissue undergoing numerical expansion. (auth)

**45712** STUDIES ON BONE MARROW TRANSPLANTATION. Mikami, Chuji (Hirosaki Univ., Japan). Hirosaki Igaku, 19: 337-54(Nov. 15, 1967). (In Japanese).

Bone marrow and spleen cells of the dog were transplanted separately or combined into mongrel dogs previously treated with 1000 R x radiation. All dogs died within four to seven days with a rapid decrease in the formative elements of the peripheral blood. Autopsies showed hemorrhagic areas in the skin, the intestine, the lungs, and complete destruction of the bone marrow. Rats were injected with bone marrow, lymph nodes, spleen, and thymus cells; after an interval of eight days the rats developed ability to form tumor antibodies. No differences were found between isologous and homologous rats. (TSS)

**45713** ON THE MECHANISM UNDERLYING DISTURBED BLOOD CLOT RETRACTION IN ACUTE RADIATION SICKNESS. Ishmukhametova, D. N. (Inst. of Medical Radiology, Moscow). Med. Radiol., 13: No. 6, 89-92(June 1968). (In Russian).

To inquire into the mechanism underlying the retraction of a blood clot in acute radiation sickness, investigations were conducted on 330 August and Wistar male rats aged three months. The evidence showed the absence of any relation between the change in the number of blood platelets and thrombocytic formula, and reduction of the blood clot retraction index. Addition, at the height of acute radiation sickness, of thrombin, fresh serum, and fresh hemolysate to the whole blood of rats was instrumental in re-establishing the deranged blood clot retraction. An inference was made to the effect that the disturbance of the blood clot retraction process in acute radiation sickness in rats is due not so much to the reduction in the number of blood platelets and a changed thrombocytic formula, but to an upset structure and deranged ability of fibrin fibers to contract. (auth)

**45714** CAPACITY OF THE PERIPHERAL NERVE TO REPAIR RADIATION LESION AFTER SUSTAINED FRACTIONAL X-RAY IRRADIATION. Evsyukov, V. I. (Central Research Roentgen-Radiological Inst., Moscow). Byull. Eksp. Biol. Med., 65: No. 6, 109-12(June 1968). (In Russian).

The reparation capacity of the fibular nerve in adult Wistar rats after radioinduced lesion sustained fractional x ray irradiation of the limb was studied. The limb was irradiated twice weekly at a dose of 60 R. Irradiation was continued for 170 days until a total dose of 3000 R was delivered. Incomplete summation of the lesion effect after fractional irradiation of the limb pointed to the capacity of tissues forming the nerve bundles for repair of radiation lesion. Regenerative tissues on the operated nerve of the irradiated limb were as marked as in the control. (auth)

**45715** ELECTROPHYSIOLOGICAL STUDY OF THE ACTIVITY OF THE RABBIT BRAIN CORTEX UNDER THE INFLUENCE OF TOTAL IONISING RADIATION. Anan'ev, V. M.; Kogan, A. M.; Hazarov, V. A. (Inst. of Biophysics, Moscow). Byull. Eksp. Biol. Med., 65: No. 6, 32-6(June 1968). (In Russian).

Electrophysiological data were recorded with the aid of an electronic computer URAL-2. Dynamics of the bioelectrical activity of the rabbit brain cortex were recorded simultaneously from 20 leads under the influence of ionizing radiation at doses of 1000 and 1500 R; it was shown that a shift in the electrophysical parameters appeared earlier after irradiation with 1500 R than after 1000 R. It was observed that the summary bioelectrical activity did not provide sufficient information; additional tests that record the duration of oscillations of the bioelectrical potentials were suggested. (auth)

**45716** HEMOPOIETIC STEM CELL SURVIVAL AND INTESTINAL CHANGES AFFECTING 30-DAY RADIATION LETHALITY IN WEANLING AS COMPARED TO ADULT MICE. Fred, Sallie Slaughter. Berkeley, Calif., Univ. of California, 1967. 61p.

Thesis.

Both hemopoietic and gastrointestinal tissues were more severely damaged in weanling than in adult mice given the same whole-body irradiation. The extent to which greater hemopoietic damage can account for the lower 30-day $LD_{50}$ of the weanlings was investigated by evaluating differences in survival and recovery of hemopoietic stem cells and related differences in bone marrow cellularity and peripheral blood granulocyte counts. Hemopoietic stem cells were assayed as colony-forming units (CFU) by the splenic colonies they form when transplanted into irradiated adult recipients. The CFU of both spleen and femur of weanlings were more radiosensitive than those of adults. In nonirradiated weanlings the number of CFU in the spleen was greater than in adults, but following irradiation the numbers were very nearly the same in both age groups whether measured by transplantation or as endogenous splenic colonies. In nonirradiated mice the number of CFU in the femur of weanlings was significantly lower than in adults. This, together with the greater radiosensitivity observed for these cells, resulted in the weanlings having less than half as many CFU in the femur as adults after a given dose of radiation. Femoral marrow cellularity during recovery following irradiation was also found to be somewhat less in weanlings than adults. Although the numbers of splenic colonies in weanling and adult mice given the same radiation dose were approximately the same, this was not associated with equal mortalities. Endogenous splenic colonies were predominantly erythroid and only rarely

granulocytic. Such colonies are unlikely to contribute much to survival, since anemia is not a major cause of death in irradiated mice. In recovering marrow, on the other hand, areas of granulocytopoiesis were abundant. The lower postirradiation granulocyte counts observed in the weanlings must, therefore, have been the result of the greater damage to the marrow. The patterns of proliferative recovery of surviving CFU of weanlings and adults were approximately the same. The principal differences in damage affecting survival was therefore death of marrow stem cells. The dose necessary to give an equal response in marrow stem cells of adults and weanlings, if extrapolated from the dose range studied, would account for approximately half the difference in 30-day $LD_{50}$, leaving an equal increment unaccounted for. Isologous marrow cells did not fully protect midlethally irradiated weanlings, precluding a greater requirement for granulocytic precursors as the reason for the discrepancy. Involvement of gastrointestinal damage is suggested by several observations. Survival times following midlethal irradiation were shorter and gastrointestinal death occurred at lower radiation doses in weanlings than in adults. The small intestine of weanling mice given midlethal irradiation has a greater and more prolonged dry weight loss as well as more severe histopathological damage, then seen in adults. Thus, in midlethally irradiated weanlings, a greater opportunity for bacterial invasion would exist at a time when cellular defenses are more depleted than in adults given the same radiation dose. (Diss. Abstr.)

**45717** EPITHELIAL TUMORS OF THE ORAL CAVITY AND PARANASAL SINUSES IN $^{90}Sr$ AFFECTION. Knizhnikov, V. A.; Vlasov, P. A.; Grozovskaya, V. A. Arkh. Patol., 30: No. 4, 26-30(1968). (In Russian).

Strontium-90 (600 microcuris per rat, sum total dose) was administered fractionally to 100 albino mongrel male rats within one week. Epithelial tumors developed 5 to 14 months later in over 25% of the animals; these tumors were localized in the nasal sinuses, oral cavity and in accessory sinuses of the skull. Two types of squamous cell carcinoma were revealed histologically: cornifying and noncornifying. Epithelial tumors occurred earlier (from the 147th day after the administration) than osteosarcomas (from the 180th day) and in a greater number of animals. No such affections were revealed in control rats. (auth)

**45718** IRRADIATION OF THE NEONATAL CANINE CEREBELLUM. Phemister, Robert David. Fort Collins, Colo., Colorado State Univ., 1967. 124p.

Thesis.

The radiosensitivity of the early postnatal canine cerebellar cortex was studied in Beagle puppies by qualitative and quantitative histologic methods. The investigation comprised three parts, viz., a description of the normal histogenesis of the canine cerebellum between the 2nd and 72nd days of postnatal life, a study of the morphologic effects produced in the cerebellar cortex by various single sublethal doses of $\gamma$ radiation (85, 170, 325 or 500 R) administered on the second postnatal day of life, and a histologic analysis of sequential stages in the pathogenesis of the changes induced by 325 R administered on the second postnatal day. A major portion of the growth and differentiation of the cerebellum was shown to occur during the first 10 weeks of life. In the first two weeks, the external granular layer remained a constant and dominant microscopic feature of the cerebellar cortex. After the second week, while the permanent cortical layers were differentiating and expanding, the external granular layer became gradually reduced in width. By the 10th week only a vestige of the layer remained and the cerebellum at this time appeared, qualitatively and quantitatively, to be practically mature. No evidence of myelination was observed in the cerebellum on the 2nd postnatal day, but the process was well advanced on the 32nd day and appeared to be complete by the 72nd day. Significant quantitative differences between control and irradiated dogs were demonstrated in the mean widths of various cortical layers at each of the four dose levels. Striking histologic malformations were observed in the cerebellar cortex 70 days after irradiation in puppies that received either 325 or 500 R as neonates, but such changes were not evident in dogs that received 80 or 170 R. Malformations at the higher doses consisted principally of ectopic clusters and poorly defined rows of granule cells in the molecular layer and of localized areas of obviously reduced cell numbers in the internal granular layer. Examination of the cerebellum at several postexposure times revealed that, shortly after irradiation with 325 R, massive and selective destruction of the external granular layer resulted in a reduction in total cortical thickness. At somewhat later sampling times a reduced internal granular layer accounted for much of the decrement in total thickness. Finally, at the 70th postexposure day a major contribution to the reduction in cortical thickness was made by the hypoplastic molecular layer. Ectopic granule cell formations were present in the molecular layer at the 30th postexposure day. Damage to the myelination process was generally mild and largely reparable by the 10th postirradiation week. (Diss. Abstr.)

**45719** THE EFFECTS OF CONTINUOUS LOW LEVEL GAMMA IRRADIATION ($^{60}Co$) ON THE REPRODUCTIVE ABILITY OF THE SPANISH GOAT. Austin, Joseph Wells. College Station, Tex., Texas A and M Univ., 1967. 114p.

Thesis.

The effects of low level continuous $\gamma$ irradiation at levels of 0, 2R, 7R, 30R and 40R per 20 hour day for the lifetime of the individual was investigated. Twelve males and 11 females were randomly assigned to each of the control, first 30R, and 40R groups. Twelve males and 12 females were assigned to each of the control, second 30R, 7R, and 2R groups. A median death time (MDT) of 56 and 50 days was observed for the 40R males and females, respectively. The MDT was the same (80 days) for both males and females in the first 30R group but in the second 30R group it was 101 and 86 days for the males and females, respectively. The MDT for the 7R males will be much longer than for the females. As of two years postirradiation, two 7R males and 8 females died of radiation sickness resulting in a MDT of 348 days for the females; the female appeared more sensitive to radiation than the male when longevity was evaluated but probably the least sensitive reproductively. The ability of females to survive in a given irradiation environment was the only definite impairment to female reproduction. All females living long enough, produced consecutive kid crops with the exception of two females in the first 30R group. One female in the second 30R group gave birth to a set of twins and 8 others were pregnant at exitus, having conceived shortly after being placed in the irradiation environment. All 7R females completed one gestation, however, eight females died prior to the time allowable for completion of the second gestation period. The other four 7R and all 2R females have completed their second gestation period and are apparently pregnant for the 3rd time. The irradiated kids in the first kid crop were somewhat smaller. However, there were no differences observed in the birth and weaning weights of the kids born as a result of the second gestation period. The effects of irradiation on male reproduction varied with the level of exposure. Total sperm production (TSP) started declining after 7 weeks of irradiation in the 40R and both 25R groups reaching essentially aspermia by the 18th week. A decline in sperm motility and percent alive occurred along with the drop in TSP. Percent normal sperm started declining on week 9 and reached a low on week 12, after which they recovered slightly before aspermia was reached. The three most predominant types of abnormal sperm in order of greatest magnitude were coiled tails, tailless heads, and protoplasmic droplets. The TSP started declining on weeks 11 and 16 and by the 22nd week the average sperm per ejaculate was only 5% and 40% of the control numbers; and by the 62nd week 7% and 26% for the 7R and 2R groups, respectively. Motility and percent normal sperm declined gradually from week 14 for the 7R and week 18 for the 2R groups. However, the percent live sperm was significantly lower than the controls in the 7R group from the 18th week but did not become significantly less in the 2R group until the 53rd week. It was concluded that small daily doses of continuous irradiation of 2R/day and above will significantly reduce the quality of the semen produced by male Spanish goats. The adult male Spanish goat, like the adult male albino rat appeared to be more sensitive than the female to daily exposures of low level irradiation over extended lengths of time. (Diss. Abstr.)

**45720** CARCINOGENIC RISK IN RADIOTHERAPY. Ratti, Arduino; Dragoni, Giovanni (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 54: 73-80(Jan.-Feb. 1968). (In Italian).

The possibility of induction of tumors by the therapeutic use of ionizing radiations is reviewed. A description is given of the histologic appearance of skin, bone, thyroid, and internal tumors following radiotherapy. Development of leukemias in irradiated humans is discussed, particularly in relation to the treatment for thymic hypertrophy, spondylitis, and thyrotoxicosis. It was concluded that an oncogenic and leukemogenic risk connected with the therapeutic use of ionizing radiations existed although it was difficult to evaluate on a quantitative basis. The need of awareness of the risk by physicians and radiologists is stressed so that optimal irradiation techniques will be used and unnecessary exposure reduced. Some numerical estimates of the carcinogenic and leukemogenic effects of radiation in man are discussed. (BBB)

**45721** OSTEORADIONECROSIS. Serna, Graciela M. (Cancer Research Center, Columbia, Mo.). Missouri Med., 64: 997-1000(Dec. 1967).

Occurrence of mandibular necrosis in the treatment of carcinoma of the floor of the mouth, clavicular and costal necrosis in carcinoma of the breast, and necrosis of the pelvis in carcinoma of the uterine cervix and of the penis was evaluated. From

1940 to 1960, of 131 patients with carcinoma of the floor of the mouth subjected to radiotherapy, 70 (7.6%) developed osteoradionecrosis of the mandible. In six cases, simple dental extractions were performed immediately before irradiation. The earliest necrosis appeared within one month and the latest, 8 yr later. The lowest dose was 2480 R in 20 days and the highest, 7000 R in 59 days plus immediate 6000 R of $\gamma$ radiation in 128 hr (5.3 days). Of 147 cases of carcinoma of the breast submitted to irradiation, 3 developed necrosis of the ribs and clavicle, simultaneously in two of them. The three cases also showed marked skin changes, and in one there was evidence of apical pneumonitis. The average skin dose was 5600 R in seven weeks of x rays generated by a 250-KV unit. Of 2063 irradiated cases of carcinoma of the uterine cervix, 89 were reirradiated; one within this group, a 64-yr-old woman developed subcapital fracture of the left femoral neck 14 months after completion of the first course, 3500 R over 76 days. In carcinoma of the penis 88 cases were irradiated and in none were there bone changes. (BBB)

**45722** MEDICAL SURVEILLANCE OF LABORATORY WORKERS EXPOSED TO IONIZING RADIATION. De Dominicis, G. Minerva Med., 59: 2272-3(May 12, 1968). (In Italian).

The indications that a physician should look for and the laboratory tests that should be made in laboratory workers during a physical examination are briefly reported. (J.S.R.)

## Radiation Effects on Plants

*Refer also to abstracts 45412, 45437, 45473, 45474, 45477, 45478, 45481–45485, 45488, 45491, 45499, 45501, 45639, and 45644.*

**45723** EFFECTS OF $\gamma$ AND $\beta$ RADIATION ON YEAST AND ITS NUCLEIC ACID PRECURSORS. Altmann, H.; Stehlik, G. (Reaktorzentrum, Seibersdorf, Austria). Monatsh. Chem., 99: 1136-42(May–June 1968). (In German).

Survival of yeast cells following $\beta$ and $\gamma$ irradiation was determined by colony-forming ability; with equal doses only slightly different effects were observed. The pattern of nucleotide distribution showed greater quantitative changes after 300,000 rad of $\gamma$ radiation than after $\beta$ radiation. The concentration of nucleoside triphosphates was reduced to a greater extent following $\gamma$ radiation. (tr-auth)

**45724** RADIOSTIMULATING EFFECT IN $\gamma$ IRRADIATED TOMATO SEEDLINGS. Abdullaev, M. A.; Berezina, N. M. (Inst. of Soil Studies and Aeronomics, Baku). Dokl. Akad. Nauk Azerb. SSR, 24: 38-41(1968). (In Russian).

Effects of $^{137}Cs$ $\gamma$ irradiation on tomato seedlings were studied. It was found that $\gamma$ irradiation with 500, 1000, and 2000 R stimulated the growth and development of plants. The harvest yield from seedlings treated with 2000 R was increased by 17.8%. The content of ascorbic acid was increased by 29.7% and that of carotin by 27.3%. (H.L.W.)

**45725** USE OF NUCLEAR VARIABLES TO INVESTIGATE RADIOSENSITIVITY OF GYMNOSPERM SEED. Miksche, J. P.; Rudloph, T. D. (North Central Forest Experiment Station, Rhinelander, Wis.). Radiat. Bot., 8: 187-92(Apr. 1968).

Variation in DNA content and nuclear volume of meristematic cells was determined for nine gymnosperm species. Wet seeds of these species were treated with acute $\gamma$-exposures from $^{137}Cs$. No relation between radiosensitivity and either DNA quantity per cell or nuclear volume was found. Thus, more precise radiosensitivity prediction methods for gymnosperm seed must be devised. However, when radiation responses of irradiated gymnosperm and angiosperm seeds were considered together, the previously established inverse relation between nuclear parameters and sensitivity to ionizing radiation was evident. (auth)

**45726** EFFECT OF TYPE AND LEVEL OF POLYPLOIDY ON RADIOSENSITIVITY IN FIVE SPECIES OF TRITICEAE. Boyle, W. S. (Utah State Univ., Logan). J. Herd., 59: 151-4(Apr. 1968).

Plants of five grasses differing in the degree of ploidy were x-irradiated with doses of 1000, 3000, 5000, and 8000 R to investigate the relation between the nature and degree of ploidy and radiosensitivity. Little or no correlation was found between type and level of polyploidy and sensitivity to acute x irradiation, as measured by mortality, growth inhibition, and dry weight production, in the following species of the Triticeae: Agropyron cristatum, A. desertorum, A. trachycaulum, Hordeum jubatum, and Agrohordeum macounii. Genetic redundancy, presumably present in the autotetraploid and autoallooctoploid, did not afford significant protection from radiation damage. Radiosensitivity was not closely related to average interphase chromosome volume (ICV) in these species. The most sensitive species was the allotetraploid H. jubatum, and three species had ICV values exceeding that of H. jubatum. A. cristatum had the highest ICV of the five species, yet it had the lowest mortality at 3000 R. (BBB)

**45727** UV EFFECT ON THE CHLOROPLAST ULTRASTRUCTURE. Shakhov, A. A.; Golubkova, B. M. (Inst. of Plant Physiology, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 1, 45-52 (Jan.-Feb. 1968). (In Russian).

An artificial uv irradiation of radish plants grown on the Aragats Mountain (3,200 m above sea level, in Armenia) resulted in a distinct destruction of the chloroplast matrix. The irradiation was performed for 10 min daily throughout a month with the aid of PRK-2 lamps ($\lambda$ = 253.7 – 365 m$\mu$). As compared to the matrix the lamellar system proved to be more stable; the less damaged section of the plastid became cup-shaped. Irradiated leaves showed a higher absorbancy within the range of 400 to 860 m$\mu$; this may have a photoreactivating effect for chloroplasts. The higher absorbancy of light energy exhibited by leaves may act as the factor maintaining the fine chloroplast structure in the state of photosynthetic activity during uv irradiation. It is suggested that unlike medium waves ($\lambda$ = 300 to 320 m$\mu$) short waves ($\lambda$ = 240 to 260 m$\mu$) do not play the part of a constructive factor and that the evolution of the photosynthetic apparatus is not related to the utilization of uv rays. Medium uv rays can promote the biosynthesis and participate in the photosynthesis of lower and higher plants. (auth)

**45728** ENDOGENOUS BETA IRRADIATION AND TUMOR PRODUCTION IN AN AMPHIPLOID NICOTIANA HYBRID. Conklin, Marie E. (Adelphia Univ., Garden City, N. Y.); Smith, Harold H. Amer. J. Bot., 55: 473-6(Apr. 1968).

A Nicotiana interspecific hybrid genetically constituted for tumor production was used to compare the effects of plant growth regulators, $^{3}H$- and $^{14}C$-labeled growth regulators, and other labeled compounds as sources of endogenous radiation, on the development of tumors at the seedling stage. The amphiploid N. suaveolens X N. langsdorffii could be induced to form tumors in the early seedling stage by treatment of the apical meristem with kinetin and indoleacetic acid. Application of $^{3}H$- or $^{14}C$-labeled plant-growth regulators resulted, in most plants, and notably with $^{14}C$-labeled indoleacetic acid, in a significant increase in the rate of tumor production over growth-regulator treatment alone. Endogenous radiation alone was shown to be tumefacient in experiments which separate the tumor-promoting effect of endogenous $\beta$ irradiation from that of the growth factors. Two labeled substances, $^{3}HOH$ and Na $^{14}C$-carbonate, assumed to be nonlocalizing and to have a high rate of exchange, were used to treat seedlings by the usual procedure, but without the addition of kinetin and indoleacetic acid. The earlier appearance of tumors on plants treated with $^{3}HOH$ and $^{14}C$ carbonate and the rapid rise in the percentage of plants with tumors showed that these radioactive substances are also effective in promoting tumor development. Tritium-labeled thymidine also consistently promoted tumor development in a higher percentage of plants than unlabeled thymidine. (BBB)

## Radiation Effects on Microorganisms

*Refer also to abstracts 45415, 45437, 45461, 45476, 45480, 45487, 45496, 45497, and 45616.*

**45729** (UCSF-10-P-2-52) ULTRA-HIGH DOSE RATE EFFECTS IN BACTERIA AND MAMMALIAN CELLS. Phillips, T. L.; Worsnop, B. R. (California Univ., San Francisco, Medical Center). [1967]. 9p. Dep. CFSTI.

Results are presented on a series of experiments designed to determine differences in RBE present with ultra-high dose rates in relation to conventional dose rates and the dose level at which oxygen depletion occurs at various oxygen concentrations. Dose response studies were performed using cultures of Pseudomonas fluorescens and cultured $LAF_1$ mouse bone marrow cells. The results obtained using ultra-high electron doses ($3 \times 10^{10}$ rads/sec) were compared to those obtained using 300 KVP X rays (3000 rads/min). It was found in both systems, though the responses were quantitatively different, that RBE was not altered at ultra-high as opposed to conventional dose rates, and that the oxygen enhancement ratio (OER) levels were lower at reduced oxygen tensions. This suggests that the efficiency of radiation therapy could be increased through the use of large individual doses combined with reduced oxygen tension. (E.R.B.)

**45730** FURTHER RESEARCH ON THE EFFECTS OF GAMMA RADIATION FROM $^{60}Co$ ON SOIL MICROFLORA. Rambelli, Angelo (CNEN, Rome). Pubbl. Centro Sper. Agr. Forest, 7: 129-46(1963). (In Italian). (RT/BIO-(66)19).

Forty-five samples of soil were investigated, taken at five different times corresponding to: February 6th, February 12th,

March 20th, April 20th, May 22nd. The influence of gamma radiation upon various groups of microorganisms was investigated. This influence was not strongly manifested. The rise in temperature from February 6th to May 22nd, and the rainfall during this period influenced the soil microflora, masking the effect of the radiation. The relationship of these opposing conditions induced in the soil microflora disorders which became increasingly apparent in the study of the various physiological groups. Inhibition in the microbial groups is particularly strong at a depth between 2 and 10 cm at a distance of 2 m from the source, where the intensity and dose accumulation of irradiation reach their highest level. This is also the case if favorable climatic conditions continue to increase. (auth)

**45731** TRANSFORMATION OF AFRICAN GREEN MONKEY KIDNEY CELLS BY IRRADIATED ADENOVIRUS 7-SIMIAN VIRUS 40 HYBRID. **Jensen, F.; Defendi, V. (Wistar Inst. of Anatomy and Biology, Philadelphia). J. Virol., 2: 173-7(Mar. 1968).**

Various functions of the viral genome can be inactivated at different rates by irradiation. At a certain dose of irradiation, infectivity (ability to replicate) of a virus may be abolished; yet other functions, involving fewer cistrons of the genome, can still be expressed. This was demonstrated in experiments in which the ability of an adenovirus 7-simian virus 40 (SV40) hybrid, LL "E-46", to reproduce infectious progeny was inactivated by $\gamma$ radiation; the virus retained its ability to transform target cells. Thus, the ability of the hybrid to replicate decreased exponentially as a function of the amount of $^{60}Co$ $\gamma$ irradiation, whereas the ability to induce SV40 and adenovirus 7 T antigen decreased at a much slower rate. Nevertheless, the virus was still able to transform African green monkey kidney cells at a radiation dose that had completely destroyed its replication ability. All transformed colonies were positive for SV40 T antigen but were negative for adenovirus 7 T antigen. The hybrid transformed cells were superinfectible with SV40 virus. Two of the three transformed cell populations apparently lacked the SV40 transplantation antigen. (BBB)

**45732** REVERSAL BY SYNGENEIC SPLEEN CELLS OF INHIBITORY EFFECTS OF DRUGS AND IRRADIATION ON FRIEND VIRUS. **Chirigos, Michael A.; March, Richard W. (National Cancer Inst., Bethesda, Md.). Antimicrob. Agents Chemother., 6: 489-96(1966).**

Splenectomy, after viremia was established, resulted in a decrease of virus in several tissues with a concomitant increase in survival time. Treatment with drugs or whole-body x irradiation resulted in marked virus reduction. The mechanism responsible for the virus reduction was considered to be the retardation of susceptible spleen cells. Lowered virus titers were observed in animals that were treated with whole-body irradiation, drugs, and splenectomy, singly or in combination. Virus reduction was totally or partially reversed when syngeneic spleen cells were administered along with the different treatments. (BBB)

**45733** EFFECT OF p-FLUOROPHENYLALANINE ON RADIATION SENSITIVITY IN ESCHERICHIA COLI. Dickie, N.; Dennis, D. A.; Thatcher, F. S. (Food and Drug Directorate, Ottawa). Can. J. Microbiol., 14: 799-803(July 1968).

An increase in the number of survivors, after $\gamma$-irradiation in the "physiological" dose range, is obtained when cultures of Escherichia coli, wild type, are grown in the presence of p-fluorophenylalanine (FPA). In contrast to this result, exposure to FPA sensitizes cells of the radiation-resistant mutant, E. coli 6$\gamma$, to $\gamma$-irradiation. The addition of FPA to a logarithmically growing culture of E. coli wild type reduces the rate of protein synthesis relative to DNA synthesis whereas, in E. coli 6$\gamma$, protein synthesis is less sensitive to FPA-inhibition than is deoxyribonucleic acid (DNA) synthesis. The results are explained by assuming that augmented radioresistance in FPA-exposed cultures of E. coli wild type reflects accumulation of cells that have terminated one round of DNA replication and not initiated a new one, analogous to the effects of amino acid starvation in bacterial cells. FPA is suggested not to act in this way in E. coli 6$\gamma$. (auth)

**45734** STUDIES ON A PIGMENT-FREE MUTANT OF NOCARDIA MINIMA. **Szymona, Olga; Szymona, Marian (Medical School, Lublin). Acta Microbiol. Pol., 17: 17-24(1968).**

A pigment-free mutant of Nocardia minima was isolated and some of its properties, including resistance to uv radiation, were examined in comparison with those of the original red strain. Both strains behaved the same in growth experiments at various temperatures on either Loewenstein or glucose-glutamate-agar medium and no reversion could be observed during a period of one year. Biochemical studies showed that the mutant is more active metabolically with regard to respiration, oxidation of lactate, and reduction of triphenyltetrazolium chloride. Analysis of phosphorus compounds proved the mutant to be richer in nucleic acids, phospholipids, and phosphoproteins. Both the N. minima strains contained inorganic polyphosphates as established on the basis of Neisser's test and the specific glucokinase reaction. Higher sensitivity to uv radiation was observed in the mutant strain, when compared with the wild type. Despite the apparently higher metabolic activity of the pigment-free mutant, its growth did not suppress that of the parent strain. The mutational change was, then, of no vital consequence for the strain studied except the greater sensitivity to uv light. (BBB)

**45735** EFFECT OF BACTERIOPHAGE $\lambda$ ON HOST CELL REACTIVATION IN ESCHERICHIA COLI K 12. Hart, M. G. R. (Queen's Univ., Belfast). J. Gen. Microbiol., 46: 321-7(Mar. 1967).

Ultraviolet sensitivity and host cell reactivation (HCR) were studied in E. coli K 12 strains Hfr C ($\lambda^+$) and Hfr B 1 ($\lambda^-$). When the survival of uv-irradiated phage T1 plated on the two different strains was plotted against the dose of uv radiation, the phage seemed to be much more susceptible to small doses of uv radiation when plated on strain Hfr C ($\lambda^+$) than when plated on strain Hfr B 1 ($\lambda^-$). For comparison the survival of irradiated phage T1 on E. coli B was tested and found to be identical with that on strain Hfr B 1. Strain Hfr C ($\lambda^+$) was thus less able to compensate for uv damage to phage T 1. Strain Hfr C showed decreased ability to reactivate uv-irradiated phage T1, as predicted from its behavior in mating experiments after thymine starvation. Thymine starvation of host Hfr B 1 bacteria resembled uv irradiation in decreasing HCR, but thymine starvation of Hfr C increased HCR, apparently as a result of $\lambda$ induction. The presence of $\lambda$ prophage in E. coli K 12 was found to decrease HCR. (BBB)

**45736** ENHANCEMENT OF MEASLES VIRUS REPLICATION IN ULTRAVIOLET-IRRADIATED CELLS. **Arita, Mineo; Matumoto, Minoru (Tokyo Univ.). Jap. J. Microbiol., 11: 337-8 (1967).**

The effect of uv irradiation of host cells on measles virus replication was investigated to support the concept that measles virus replication is independent of the DNA function of the host cell. The virus strain used was a cloned line of the Sugiyama strain. Virus grown in human amniotic FL cells was used for inoculation. FL cells irradiated for 15 sec or less supported enhanced multiplication of measles virus. The yield of active virus in irradiated cells at both 23.5 and 27 hr increased exponentially with the dose of uv light and reached a peak about 10-fold greater than the virus yield in unirradiated control cells. When cells were irradiated for 20 sec or longer, the virus yield became increasingly smaller. The 23.5-hr yield in irradiated cells reached the same level as the control cells after 60 and 80 sec of irradiation. The 27-hr yield declined to the control level after 40 to 60 sec of irradiation, and declined further after 80 sec of irradiation. (BBB)

## Radiosterilization and Radiopreservation

*Refer also to abstract 45437.*

**45737** EFFECT OF IONIZING RADIATION ON SOME NUTRITIONAL AND BIOCHEMICAL PROPERTIES OF PAPAYA. **Hilker, Doris M.; Young, Richard L. (Univ. of Hawaii, Honolulu). Hawaii Farm Sci., 15: 9(Jan. 1966).**

Total vitamin C activity was determined in papaya under different radiation doses and degrees of ripeness by the 2,4-dinitrophenylhydrazine method after oxidation of ascorbic acid to dehydroascorbic acid. Experiments to determine protein, proteolytic enzyme activity, pectin content, and pectin characteristics of papaya were carried out on individual mature green or breaking-yellow fruits of commercial varieties. Doses of 300, 100, and 25 Krad were used; 100 Krad was slightly over the maximum proposed quarantine treatment. There was no appreciable change in the ascorbic acid at any stage of ripeness or irradiation dose tested. The only significant change observed was the de-esterification of pectin leading to an increase of pectic acid. This de-esterification increased with increasing dose of radiation, indicating that it was a direct effect of $\gamma$ rays on pectin. Although this change may cause the immediate decrease in fruit firmness that was noticed after irradiation, the plant enzymes restored pectin esters to normal amounts 3 to 5 days after irradiation. Thus, the nutritional value in these constituents was not altered by radiation doses many times that required for insect disinfestation. (BBB)

**45738** RECENT DEVELOPMENTS IN FOOD IRRADIATION. Ley, F. J. (Wantage Research Lab., Eng.). Atom, No. 130, 224-7(Aug. 1967).

A review of food irradiation research on safety processes is presented in view of the need for specific legislation. In the United States, the Food and Drug Administration has cleared three food products: bacon, white potatoes, and wheat and wheat flour. Ten food products are pending approval. Research on radiopreservation of food in various countries is reviewed. Operation of the process under commercial conditions is still awaited, since industry is discouraged by the need to accumulate scientific evidence of safety for consumption. (H.L.W.)

**45739** THE STERILIZATION AND PRESERVATION OF HOMOLOGOUS ARTERIAL SEGMENTS, WITH SPECIAL REFERENCE TO THE HEART VALVES. Rob, Charles (Strong Memorial Hospital, Rochester, N. Y.). Surgery, 63: 875-6(May 1968).

A comparison of the success of 274 homologous arterial transplants, sterilized by various methods, revealed that radiosterilization was the least effective method. The best method of sterilizing arterial segments was with antibiotics. Other methods of sterilization, particularly by irradiation, appeared to damage the arterial wall, and the incidence of thrombosis in arterial transplants was higher if irradiation or chemical sterilization was used. Five out of six irradiated samples (83%) became thrombosed, compared to 67% for ethylene oxide-treated, β-propiolactone-treated, and 20% for antibiotic-treated samples. (BBB)

**45740** ACTION OF γ RAYS ON THE PRESERVATION OF ARRACACIA XANTHORRHIZA (APIO). Revetti, Luis M. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Acta Cient. Venez., 18: Suppl. 3, 349-51(1967). (In Spanish).

Doses of $^{60}$Co γ rays between 10 and 11 Krad were found to double the shelf life of the tubers of A. xanthorrhiza, without decreasing its food value. Changes in wt of the tubers; their starch, ascorbic acid, and reducing sugar content; and catalase activity were determined one, two, three, and four weeks post-irradiation. Loss of weight was about 1/5 as high after 10 Krad and 1/2 as high after 11 Krad as that in controls after three weeks. Ascorbic acid was almost twice the control level at two weeks while reducing sugars were 1/2 the control level with both doses at this time. Catalase activity was similar in control and irradiated groups at two weeks after irradiation, the last period at which control samples were assayed. (BBB)

**45741** EFFECTS OF GAMMA IRRADIATION ON THE PINEAPPLE. Upadhya, Mahesh D.; Brewbaker, James L. (Univ. of Hawaii, Honolulu). Hawaii Farm Sci., 15: 8-9(Jan. 1966).

Acceptability and shelf life of radiation-disinfested pineapple were examined. Preliminary studies indicated that irradiation doses exceeding 100 Krad led, during prolonged storage, to discoloration of both flesh and shell. These adverse effects increased with increasing dose, and were more pronounced in half-ripe fruits (i.e., 50% yellow) than in the fully ripe fruits. Half-ripe fruits of the Smooth Cayenne variety were treated with 30, 40, 50, and 100 Krad of γ irradiation and stored for two weeks at different temperatures. The fruits were then examined for shell color and bronzing, crown (leaf) damage, flavor, and total soluble solids (sweetness). It was concluded that a storage temperature of 45°F was optimal for irradiated fruits. At the 100 Krad level the quality was somewhat reduced. Irradiated half-ripe fruits were comparable to the controls in shell color, crown damage, and flavor. However, prolongation of marketable life was evident at all irradiation doses as noted in data on shell color and sweetness. It was concluded that disinfestation of the pineapple by irradiation in the dose range of 30 to 50 Krad brought about a significant extension of shelf-life without producing undesirable changes in fruit appearance or quality. The crowns of irradiated fruits could not be used to establish growing plants since irradiation (about 15 Krad) inhibited rooting. (BBB)

**45742** EXTENDING THE SHELF LIFE OF PAPAYAS WITH GAMMA IRRADIATION. Akamine, Ernest K.; Wong, Roland T. F. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-235. Hawaii Farm Sci., 15: 4-6(Jan. 1966).

The effect of γ irradiation on extension of shelf life of fresh papayas intended for the export market is reported. The following apparent upper limits of doses for overall fruit tolerance were indicated in fruit of various stages of ripeness when irradiated: surface scale, 100 Krad; surface color development, 200 Krad; flavor and aroma, 400 Krad; and tissue breakdown, 500 Krad. Thus the maximum dosage of irradiation the papayas could tolerate was limited by the development of surface scalding (darkening) at 100 Krad. Doses above this caused progressive increase in scalding. Irradiated fruits were firmer than untreated fruits; at 80 to 160 Krad maximum firmness was attained. There was no further increase in firmness with a higher dose. A dose of 75 Krad was effective for delaying the softening of fruits for more than two days. Whereas untreated fruits were all overripe in three days after the edible ripe stage, the irradiated fruits required six days to begin to become overripe. Tests indicated that for controlling storage decay in papayas with irradiation, relatively high doses (600 Krad and higher) that are injurious to the fruit were required. Within the practical range of 75 to 100 Krad, the treatment merely retarded slightly the appearance of decay lesions concomitant with delayed softening without inhibiting the decay. Therefore, the hot water treatment that is commercially used for controlling storage decay in export papayas was used as a means of checking the decay in irradiated fruits. When the hot water treatment was incorporated into 75-Krad irradiation treatment, complete control of decay was obtained. The combination of hot water plus 75-Krad irradiation treatment may feasibly replace the currently used hot water plus fumigation method, at least for air-shipped papayas. The shelf life of irradiated fruits may be extended at least three days beyond that of fumigated fruits after the fruit becomes edible ripe. The three days may represent as much as a 100% or greater increase in the salable life of the fruit. (BBB)

**45743** BIOLOGICAL EFFECTS OF IRRADIATED FOOD. III. EXPLORATORY STUDIES OF THE EFFECT ON THE THYMUS. Loefroth, G.; Ernstroem, U. Ark. Zool., 19: 537-42 (1967).

Earlier results indicated that male rats fed irradiated food may show a change in thymic weight differing from that of control animals, in addition to a highly significant, 15 to 20%, decrease in the absolute lymphocyte number in the peripheral blood. The possibility of a reduced rate of thymic involution caused by irradiated food was further explored in male rats and male and female mice. The results confirmed that male rats fed irradiated food to 50% of the total diet show a decreased rate of thymic involution as compared to that in controls. The thymi had an unchanged cell density and cell production per unit volume, the increased weight thus indicating an increased number of cells in the thymus of the experimental animals. Male mice fed irradiated food to 50% of the total diet also showed a decreased rate of thymic involution and, in addition, had a lower body weight than controls at the end of the feeding period (age about 57 days). A simple stress reaction was ruled out to explain the results, since loss of body weight by stress is accompanied by accentuated thymic involution. Female mice fed irradiated food showed no change in thymic involution, but a possible effect may have been obscured, as females have a fairly slow rate of involution in comparison to males. No overall significant effects on spleen weight were observed. (BBB)

**45744** GENETIC METHODS OF INSECT PEST CONTROL. Rukavishnikov, B. I. (Inst. of Scientific and Technical Information, Moscow). Genetika, 4: No. 6, 128-43(June 1968). (In Russian).

The exposure to sterilizing doses of physical (X rays and γ rays) and chemical (alkylating agents, antimetabolites etc.) mutagens induce lethal mutations in different animals. In some insects and mites oogenesis was inhibited by mutagens, the oviposition being thus prevented. As sterilizing chemical agents for females, the most efficient were some antimetabolites of folic acid, pyrimidines, and purines. The best methods of sterilization of males were by γ rays and by some derivatives of ethylenimine. Sterilized males of insects produced motile sperm, but females after mating with such males deposited unviable eggs, in which the embryonic development was either inhibited, or interrupted before the larval stage was reached. The periodic flushing of the natural populations of a harmful species with such sterile males throughout several generations can result in the extermination of this species over vast areas. Conditions for the success of genetic methods of insect pest control are pointed out. (auth)

# METALS, CERAMICS, AND OTHER MATERIALS

## Metals and Alloys

*Refer also to abstracts 45028 and 45799.*

**45745** (UCRL-18043, pp 107-53) METALLURGY. (Univ. of California, Berkeley).

Research and development progress is reported on crystal imperfections, kinetics of dislocation mechanisms, relations of structure with properties of crystals, properties of high-strength materials, high-field superconductivity, and thermodynamics of metal systems. (J.R.D.)

### Corrosion and Erosion

**45746** (EURAEC-2026) RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 483-15. Cox, Thomas B.; Eckel, John F. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Apr. 1968. Contract AT(40-1)-3208. 22p. Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The solid solubility of nitrogen in AISI Type-384 stainless steel was determined for selected temperatures in the range of 538 to 982°C. Extensive experimentation and development of an acceptable thinning procedure have been carried out to facilitate the production of thin foils from the cracked Type-304 U-bend specimens. The thin foils are to be used in studying the stainless steel by transmission electron microscopy. (auth)

**45747** CORROSION FATIGUE AND STRESS-CORROSION CRACKING IN AQUEOUS ENVIRONMENTS. Piper, D. E.; Smith, S. H.; Carter, R. V. (Boeing Co., Renton, Wash.). Metals Eng. Quart., 8: No. 3, 50-63(Aug. 1968).

Quantitative measurements of corrosion fatigue and stress corrosion cracking, in several Ti alloys, were made by laboratory tests in which fracture mechanics methods were employed in comparing and analyzing material behavior. (P.G.C.)

**45748** INHIBITING THE WEAR AND GALLING CHARACTERISTICS OF TITANIUM. de Laat, Frans G. A. (Thompson Ramo Wooldridge Inc., Redondo Beach, Calif.); Adams, T. Metals Eng. Quart., 8: No. 3, 39-48(Aug. 1968).

A protective layer, to inhibit wear and galling on Ti alloy surfaces, is applied by passing direct current through a chemical bath in which the metal is suspended. The metal serves as the anode in the alkaline bath. The coating does not induce corrosive attack and measurements indicate that it may be classified between a semiconductive and dielectric material. (P.G.C.)

**45749** THE CONTRIBUTION OF METALLOGRAPHY TO THE STUDY OF SOME CORROSION PHENOMENA OBSERVED IN PIPES OF COPPER ALLOY OF CONDENSERS. Galletto, E. (ENEL-DCTN, Piacenza, Italy); Gasparini, R. Met. Ital., 60: 528-34 (June 1968). (In Italian).

In thermal and nuclear plants, numerous corrosion phenomena, observed in the tube nests of copper alloy condensers, have been identified by metallography. Verification of secondary intergranular removal of Zn from Al-containing alpha brass pipes in seawater condensers was established. Typical phenomena of corrosion under stress and of erosion-corrosion have been observed in other tube nests of copper alloy with the circulation of sea and fluvial water. In some cases a semiquantitative control of the phenomenon on all the tube nest, by means of eddy-currents, has been possible because of the contemporary utilization of the metallographic analysis. (tr-auth)

**45750** RADIATSIONNAYA KORROZIYA. (Radiation Corrosion). Byalobzheskii, A. V. Moscow, Izdatel'stvo Nauka, 1967. 216p.

A brief review is given on the characteristics of radiation effects on metals, water radiolysis, and radiation effects on electrochemical corrosion processes. The mechanism of destructive radiolytic and photo-radiative effects on metals, kinetics of corrosion processes, and radiation effects on iron, aluminum, zirconium, titanium, and their alloys are studied in electrolytes, in the atmosphere, and halogen-organic media. 182 references. (R.V.J.)

**45751** BREAKAWAY OXIDATION TRANSITION FOR A ZIRCONIUM-2.7 w/o NIOBIUM ALLOY. Cowgill, M. G.; Wong, S. H.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). J. Electrochem. Soc., 115: 927-9(Sept. 1968).

Studies were made to determine if $\alpha$- and $\beta$-Zr could be distributed in the Zr-2.7 wt. % Nb alloy by diffusion processes to influence the reaction kinetics within brief exposure periods at temperatures in the range 870 to 1000°C. The results showed that at all temperatures, the curves were initially parabolic. At and below 912°C, this type of oxidation for exposures up to 60 min was followed by a breakaway transition leading to more rapid reaction kinetics. Specimens oxidized at 870 and 912°C exhibited after transition from parabolic kinetics uneven oxide growths with many cracks present in the scale. The results are consistent with the reasoning that the different oxidation characteristics and alloy microstructures found at the extreme temperatures in the range 870 to 990°C were dependent on the oxygen solubilities and the rates for oxygen diffusion in the alloy phases. (P.C.H.)

**45752** OXIDATION OF VANADIUM-BASE ALLOYS BY LIQUID SODIUM CONTAINING DISSOLVED OXIDES IN TEMPERATURES RANGING FROM 500 TO 600 C. Borgstedt, Hans U.; Frees, Gunter (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Corrosion, 24: 209-13(July 1968).

Vanadium-base alloys suffer oxidation by liquid sodium (500 to 600°C) containing 5 to 10 ppM oxides. The effects are different with differing components of the alloys and the degree of purity of liquid sodium. In liquid sodium of a pumped sodium loop, V-Ti alloys with 5 to 20% Ti suffer embrittlement of surface areas. The zones of embrittlement contain up to 7 to 9% oxygen. Unalloyed vanadium is not conducive to oxygen diffusion into the metal phase. The different behavior is intelligible from thermodynamic reasons. The free energy of oxygen exchange between $Na_2O$ and the refractory metals following the equation, $Na_2O + V = VO + 2\ Na$, is small, in the reaction with vanadium, but remarkable in the reaction with titanium in the above range of oxygen concentrations. Depth of the penetration zone of the metallic phase is dependent on Ti content. After 500 hours testing at 600°C, the following depths were measured: 200 microns in V-5% Ti, 100 in V-10% Ti, and 70 in V-20% Ti. In alloys with less than 5% Ti, complete embrittlement occurred through the specimen of 0.5 mm thickness. In some tests with cold trapped sodium with plugging temperatures of less than 130°C severe corrosion weight losses and oxide layers were observed. Beneath these oxide layers, there were the well known oxygen diffusion layers. X-ray fluorescence analysis showed that oxide layers contained calcium up to 5% concentration. (auth)

**45753** EFFECTS OF URANIUM ON STRESS CORROSION CRACKING OF STEELS IN A NITRATE ENVIRONMENT. McDonald, R. D. (Dept. of Energy, Mines, and Resources, Ottawa). Corrosion, 24: 214-17(July 1968).

Corrosion tests in a boiling nitrate environment show beneficial effects of uranium in steel in quantities up to 0.15%, the preferred level being at 0.09%. Steels included in the tests contained two levels of carbon and three levels sulfur at strength levels within the range 135,000 to 155,000 psi. (auth)

### Preparation and Fabrication

*Refer also to abstracts 45229, 45265, 46925, and 47053.*

**45754** (CONF-671063-2) FABRICATION TECHNIQUES OF BERYLLIUM METAL REMOVAL. Paul, G. Raymond (Speedring Corp., Warren, Mich.). [nd]. 7p.

From Aeronautic, Space Engineering and Manufacturing Meeting, Los Angeles, Calif.

Techniques used in the machining of Be are outlined from the viewpoint of mechanical properties, health hazards, machining characteristics in turning, milling, drilling, grinding, honing and lapping, electric discharge machining, chemical etching, and electropolishing. (P.G.C.)

**45755** (NAA-SR-12629) PREPARATION OF UC AND UC-W SPECIMENS FOR AN IRRADIATION TEST OF THE VALUE OF A FINE-PARTICLE DISPERSION IN THE CONTROL OF FISSION GAS SWELLING (EXP-NRX-9-101 EXPERIMENT). Hott, A. C. (Atomics International, Canoga Park, Calif.). May 31, 1968. Contract AT(04-3)-701. 41p. Dep. CFSTI.

The preparation and characterization of fuel samples for an irradiation test of fission gas swelling in tungsten-doped uranium monocarbide are described. Details are given on the arc melting and casting and the zone melting processes used to prepare the 0.33-in. diameter fuel slugs. Tungsten was added, and the carbon-to-metal (U + W) stoichiometry was controlled by a zone leveling procedure. The purpose of the tungsten addition was to provide a dispersion of very fine particles to trap fission gas bubbles and limit swelling. Electron micrographs are presented

which show the presence of fine particles. The fuel samples have been further characterized by chemical analysis, optical metallography, length measurement, and density determination. Density change is the chief measure of the swelling which occurs during irradiation, and the comparison of the swelling of the tungsten-containing samples with that of the control samples is the chief indication of the value of tungsten additions for the reduction of fuel swelling. The density and other properties of the 114 fuel slugs for use as reference data during the postirradiation examination are given. (auth)

**45756** (UJV–1994) TECHNIQUES FOR MELTING AND CASTING OF URANIUM AND ITS DILUTE ALLOYS. Kaderabek, E.; Sokol, L. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1968. 43p. (In Czech). Dep.

Equipment and techniques used for melting and casting of uranium and its alloys are reviewed. Refractory materials are assessed from the standpoint of their thermodynamic and other physical properties and compatibility with molten uranium. Also summarized are experimental results and experiences in melting and casting of uranium and some dilute alloys. Particular attention is paid to melting in crucibles of sintered alumina, chemical homogeneity problems and defects of castings. (auth)

**45757** (WARD–3791-20) VANADIUM ALLOY CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending June 30, 1968. Bishop, E. C.; Nadler, R. A.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). July 1968. Contract AT(30-1)-3791. 60p. Dep. CFSTI.

Progress in the development of V alloy fuel cladding is reported. Details are given of investigations of sodium corrosion, alloy selection and fabrication, fuel element design, structural and mechanical properties, alloy-fuel compatibility, and irradiation performance. (P.G.C.)

**45758** BRAZE ALLOYS FOR TITANIUM FOIL STRUCTURES. Compton, W. A.; Smeltzer, C. E.; Malik, R. K.; Hammer, A. N. (International Harvester Co., San Diego, Calif.). Metals Eng. Quart., 8: No. 3, 27-32(Aug. 1968).

Titanium-base brazing alloys were developed, which have good strength and corrosion and oxidation resistance, for titanium foil structures and for titanium alloy tube-and-shell heat exchangers. The processes did not embrittle the base metal. (P.G.C.)

**45759** PREPARATION OF URANIUM TARGETS BY THE ELECTROSPRAY METHOD. Tawara, Hiroyuki; Hyakutake, Mikio (Kyushu Univ., Fukuoka). Genshikaku Kenkyu, 13: 13-20(June 1968). (In Japanese).

An electrospray method for preparation of a uranium target of large area (30 × 40 mm) with good uniformity at a thickness up to 1 mg/cm$^2$ is described. Some precautions on the use of the method are given. (NSA of Japan)

**45760** THE TECHNOLOGY OF THE MANUFACTURE OF SEMIFINISHED PRODUCTS OF SINTERED ALUMINUM-ALUMINA MATERIAL (SAP). Bertazzoli, F. (Societa Montecatini Edison, Feltre, Italy); Anselmi, A.; Belvedere, C.; Buergers, W. Met. Ital., 60: 535-47(June 1968). (In Italian).

The essential characteristics of the sintered materials Al – $Al_2O_3$ (SAP) are described. The technology and the results regarding production of drawn pipes of great size are discussed. The material starting from powder containing 10% of $Al_2O_3$, is to be used, as tube of force, in project Orgel. (tr-auth)

**45761** IMPROVEMENTS IN THE TREATMENT OF STAINLESS STEEL TUBES. Haberlin, Michael Melrose; Lloyd, Henry; McLean-Elrick, Alexander (to United Kingdom Atomic Energy Authority). British Patent 1,124,287. Aug. 21, 1968. Filed Dec. 3, 1964.

The bursting ductility and high-temperature ductility of austenitic stainless steels, used for nuclear reactor fuel cladding, are improved by lowering the interpass annealing temperature from 1050°C to a temperature in the range of 800 to 900°C and repeating cold working by planetary swaging and annealing at least once. (P.G.C.)

**45762** IMPROVEMENTS IN OR RELATING TO A METHOD OF, AND A TOOL HEAD FOR, SPINNING OVER THE END PORTION OF A TUBULAR MEMBER. Parsons, John Desmond (to United Kingdom Atomic Energy Authority). British Patent 1,124,984. Aug. 21, 1968. Filed Mar. 18, 1965.

A method and a tool are described for sealing reactor fuel pellets in Al canisters or other containers by spinning and shearing the closing disc in one operation. (P.G.C.)

## Properties Evaluations

*Refer also to abstracts 45223, 45258, 45263, 45264, 45757, 46857, 46925, 47006, and 47040.*

**45763** (BMI–1847) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Quarterly Progress Report, April–June 1968. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). July 1, 1968. Contract W-7405-eng-92. 23p. Dep. CFSTI.

Activities in a program to define defects associated with fractures in typical PWR and BWR primary-coolant piping are reported. During the reporting period failures of A106B pipe were examined. Data are included on 24-in.-dia pipe having 1.70-in.-thick walls. Calculated data are also included on stress intensity as a function of crack length and on flow stress in A106B pipe. (J.R.D.)

**45764** (NAA-SR-Memo-4998) POST-SERVICE METALLURGICAL EXAMINATION OF BELLOWS-TYPE CORE TUBE. Page, J. P. (Atomics International, Canoga Park, Calif.). Mar. 3, 1960. 17p. Dep. CFSTI.

A post-service metallurgical analysis of the materials of construction and welds of portions of the bellows-type core tubes from the Griscom–Russell 3000 kW steam generator was performed and the results are summarized. 2¼Cr-1 Mo steel was concluded to be satisfactory for core tube application provided that specific recommendations on welding material and techniques are followed. (L.C.L.)

**45765** (RPI–1044-18) ANISOTROPIC DIFFUSION AND ELECTROMIGRATION. Annual Report. Huntington, H. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). July 1968. Contract AT(30-1)-1044. 10p. Dep. CFSTI.

Results of research are reported on Zn electromigration, Ag electromigration, transport in liquid Na–K systems, electromigration of body-centered refractory metals, diffusion of Ag in Zn, and diffusion of Zn in Cd. Results of theoretical studies are included on dynamics of atom motions. (J.R.D.)

**45766** (SC-DC-68-2385) REQUIREMENTS OF CAPSULE MATERIALS. Holland, J. R. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1968. 26p. (CONF-681002-3). Dep. CFSTI.

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn.

The requirements of capsule materials for radioisotope heat sources are reviewed and classified as those requirements resulting from: the type of fuel and its form; the operating conditions such as temperature and life; the anticipated and potential environments, such as launch accidents, space vacuum, and reentry; and considerations of mutual compatibility and stability. These requirements are discussed with regard to current practice, materials knowledge, and future needs with emphasis on space applications. (L.C.L.)

**45767** (UCID–15362) THE YIELD SURFACE OF URANIUM + .75 PERCENT TITANIUM. Green, E. A. (California Univ., Livermore. Lawrence Radiation Lab.). July 30, 1968. Contract W-7405-eng-48. 45p. Dep. CFSTI.

The first and fourth quadrant yield surfaces were determined for a U–Ti alloy. The effect of electron beam welding was tested by making one complete specimen from identical halves welded together by this method. The testing program revealed that the weld metal is stronger than the off-weld metal. Fracture did not start or propagate through the weld. The tentative biaxial yield surface is best described by the maximum strain criterion and is poorly described by the Mises ellipse. The material is anisotropic; in biaxial stressing where the hoop and axial stresses were equal, the axial gages indicated 0.05% offset at a lower stress than the hoop gages. (M.C.G.)

**45768** EFFECT OF BETA FORGING ON SEVERAL TITANIUM ALLOYS. Coyne, J. E.; Heitman, G. H.; McClain, J.; Sparks, R. B. (Wyman-Gordon Co., North Grafton, Mass. Wyman-Gordon Co., Harvey, Ill.). Metals Eng. Quart., 8: No. 3, 10-15(Aug. 1968).

The forging of Ti–6Al–4V, Ti–8Al–1Mo–1V and Ti–6Al–2Sn–4Zr–2Mo above the $\alpha + \beta/\beta$ transus can be performed without a significant reduction in mechanical properties. In some instances properties such as fracture toughness are improved. A qualitative comparison of $\alpha + \beta$ and $\beta$ processed material is shown. Based on these data, it appears that greater shape refinement can be achieved in making titanium forgings if the material is forged in the $\beta$ field. In order to achieve satisfactory properties, sufficient plastic deformation is needed during forging to produce a worked (distorted) $\beta$ grain. Additional work is needed to better determine

the effect of $\beta$ forging on fatigue strength both low cycle and high cycle. (auth)

**45769** THE EFFECT OF ALPHA + BETA AND BETA FORGING ON THE FRACTURE TOUGHNESS OF SEVERAL HIGH-STRENGTH TITANIUM ALLOYS. Heitman, G. H.; Coyne, J. E.; Galipeau, R. P. (Wyman-Gordon Co., North Grafton, Mass.). Metals Eng. Quart., 8: No. 3, 15-18(Aug. 1968).

Forgings of eight $\alpha + \beta$ Ti alloys and one $\beta$ alloy were investigated for mechanical properties from −100 to 500°F. Room-temperature yield strengths, notched tensile tests, and fracture toughness values are compared graphically. With the same heat treatment, the $\alpha + \beta$ forgings had yield strengths of 3000 to 15,000 psi greater than the forged $\beta$ material and greater ductility. The $\beta$ forged material had superior notched tensile strength and in most cases superior fracture toughness. At −100°F significant reduction in notched tensile strength was noted in all alloys. Improvement in fracture toughness as a result of $\beta$ forging indicates that this method of processing should be used when the $\alpha + \beta$ alloys are heat treated to high strength. (P.G.C.)

**45770** CREEP OF TITANIUM ALLOYS. Katcher, M. (Northrop Corp., Hawthorne, Calif.). Metals Eng. Quart., 8: No. 3, 19-27(Aug. 1968).

The influence of crystal structure, strain aging, H embrittlement, cold working, and annealing on the elevated temperature strength and creep rupture strength of Ti alloys for aircraft and aerospace structures is reviewed. (P.G.C.)

**45771** PHYSICAL METALLURGY AND METALLOGRAPHY OF TITANIUM ALLOYS. Seagle, S. R.; Bartlo, L. J. (Reactive Metals, Inc., Niles, Ohio). Metals Eng. Quart., 8: No. 3, 1-10 (Aug. 1968).

The influence of composition, heat treatment, and phase transformations on the tensile properties and fabricability of Ti base alloys with Al, Cr, Fe, Mo, Sn, V, or Zr is discussed. (P.G.C.)

**45772** DIFFUSION OF BERYLLIUM INTO IRON AND NICKEL. Grigor'ev, G. V.; Pavlinov, L. V. Fiz. Metal. Metalloved., 25: 836-9(May 1968). (In Russian).

The diffusion of Be into Fe and Ni at temperatures from 1100 to 1350°C (Fe) and 1020 to 1400°C (Ni) was investigated. The diffusion coefficients were determined by the integral surplus method using the radioisotope $^{7}Be$. The temperature dependence of the diffusion coefficients was described by the equations: $D_{Fe} = 0.1 \exp(-57{,}600/RT)$ cm²/sec and $D_{Ni} = 0.019 \exp(46{,}200/RT)$ cm²/sec. (tr-auth)

**45773** VNUTRENNEE TRENIE V METALLAKH I SPLAVAKH. (Internal Friction in Metals and Alloys). Tavadze, F. N.; Postnikov, V. S.; Gordienko, L. K. (eds.). Moscow, Izdatel'stvo Nauka, 1966. 244p.

The forty eight articles of the book include systematical, theoretical and experimental data on internal friction and elasticity of metals and alloys at various temperatures, loads, phases, and polymorphic transformations in various media. Radiation effects, magnetic field, and crystalline structure influence on the elastic and inelastic properties of metals are analyzed as well as processes of diffusion, reversibility, creep and aging. The book is divided into five chapters. The first chapter handles the internal friction in pure metals and non-magnetic alloys; the second, the internal friction in steels; the third, the internal friction in construction materials at large oscillation amplitudes. The fourth chapter covers the instruments and methods for measuring internal friction, and the fifth includes the theory of internal friction. (R.V.J.)

**45774** INFLUENCE OF RUTHENIUM ADDITION ON HEAT CONDUCTIVITY OF NIOBIUM. Panteleimonov, L. A.; Nesterova, O. P.; Akhmetzyanov, K. G. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 98-9(May-June 1968). (In Russian).

The thermal conductivity of niobium alloys containing 1, 5, 10, and 20 at. % ruthenium was shown to increase approximately to 15% in the temperature range from 50 to 350°C. (auth)

**45775** NEW MATERIALS IN THE AEROSPACE INDUSTRY. PART 2. Meckelburg, E. Chem. Rundsch. Solothurn, 41: 757 (Oct. 11, 1967).

Newer developments in Ti and Al alloys suitable for aerospace and cryogenic applications and protective coatings for W, Mo, Ta, and Nb are briefly reviewed. Alpha Ti alloys are used in the compressors of jet engines. The new British IMI 679 alloy is intended for high-stress applications between 300 and 350°C. High-strength, tough alpha-beta alloys are being developed by modifications to Ti-6Al-6V-2Sn and by Fe and Cr additions to other alloys. The new beta alloy, Ti-12Mo-6Sn, has a tensile strength of 13,000 kp/cm², is weldable and has improved resistance to salt stress corrosion. New heat treating methods improve the stress corrosion resistance of the Al alloys, 7001, 7075, and 7178. The only alternatives for the highly developed silicide coatings for refractory metals are aluminides (AlSn), applied by slip-coating methods. (auth)

**45776** SOME METALLOGRAPHIC TECHNIQUES APPLIED TO MOLYBDENUM SINGLE CRYSTALS. IV. DETERMINATION OF DISLOCATION DENSITY FROM ELECTRON MICROGRAPHS OF MOLYBDENUM. Irwin, Gerald J.; Otto, Brigitte (London Univ.). Prakt. Metallog., 5: 452-6(Aug. 1968). (In English and German).

An indirect method of dislocation density determination from electron micrographs has been applied to foils of single crystal molybdenum. Optimum conditions and precautions for such a determination were noted and a description of procedure is included. A worked example was used for illustration. (auth)

**45777** INVESTIGATION OF ZIRCONIUM SINTERING ON MODELS. Spivak, I. I.; Andrievskii, R. A.; Chevasheva, K. L. Porosh. Met., Akad. Nauk Ukr. SSR, No. 6, 41-6(June 1968). (In Russian).

Studies of the sintering processes of $ZrI_4$ spheres, in He, and under vacuum were made. Sintering in He at 1265 to 1810°C occurred by means of diffusion transfer of material whereas during sintering in vacuum at pressures of $10^{-4}$ to $10^{-5}$ mm Hg and 1500 to 1800°C evaporation-condensation mechanisms prevailed. From the results of the study the parameters of self-diffusion and evaporation are estimated and equations are deduced for the self-diffusion coefficients and vapor pressure of Zr over the stated temperature range. (P.G.C.)

**45778** MECHANICAL PROPERTIES OF TITANIUM ALLOYS AT CRYOGENIC TEMPERATURES. Christian, J. L.; Hurlich, A. (General Dynamics/Convair, San Diego, Calif.). Advan. Cryog. Eng., 13: 318-33(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

Tensile properties and notch toughness data, as determined from edge notched sheet specimens, are given at 75, −100, −320, and −423°F for commercially pure titanium, eight commercial alloys, and several experimental alloys. Also reported are the results of special studies on the effect on notch toughness of: cold working on alloy Ti-5 Al-2.5 Sn; various heat treatments on alloy Ti-8 Al-2 Cb-1 Ta alloy; and interstitial content. (auth)

## *Structure and Phase Studies*

*Refer also to abstracts 46060, 46254, 46256, and 46260–46266.*

**45779** (LA-tr-68-35) THE CONDITIONS FOR THE EXISTENCE OF THE LAVES PHASES IN INTERMEALLIC SYSTEMS. del Litto, Bernard. Translated by Rose Mary Boicourt (Los Alamos Scientific Lab., N. Mex.), from report CEA-BIB-92. 26p. Dep. CFSTI.

A definition is given of Laves phases, and their structures and distribution are discussed. The factors that determine the existence and structure of the Laves phases are studied including size factor and electronic concentration. Available thermodynamic data are tabulated, and the interpretation of the Laves phases is discussed. 33 references are included. (D.L.C.)

**45780** (NYO-3830-6) A LEED STUDY OF THORIUM OVERLAYERS ON A TANTALUM (100) SUBSTRATE AND EVIDENCE FOR INITIAL PSEUDOMORPHISM FOLLOWED BY THORIUM CLUSTERING. Pollard, J. H.; Danforth, W. E. (Bartol Research Foundation, Swarthmore, Pa.). June 1968. Contract AT(30-1)-3830. 26p. (CONF-680611-2). Dep. CFSTI.

From 4th International Materials Symposium on the Structure and Chemistry of Solid Surfaces, Berkeley, Calif.

An investigation of the nature of thorium overlayers grown on a tantalum (100) substrate at 950°C is reported. A study of the LEED pattern change as thorium is deposited shows the thorium atoms form a c(2 × 2) structure. The intensity change of the $(\frac{1}{2},\frac{1}{2})$ spots with increasing coverage shows this structure to occur in island formation up to a density of $3 \times 10^{14}$ atoms/sq cm. Further thorium deposition does not complete this structure but rather forms a (1 × 1) registry with the tantalum substrate in a two dimensional pseudomorphic structure up to one monolayer. A careful calibration of coverage for 20 monolayer equivalent of thorium from both a thermionic emission measurement of a control tungsten ribbon and from an $\alpha$ particle counting technique has shown further that the thorium forms predominantly in small rectangular clusters. These clusters were observed optically. An electron micrograph of the surface has shown the thorium islands to be between 100 and 1000 Å in height. The results are consistent with

LEED intensity data of the (00) beam which did not show any appreciable change in the position of the Bragg peaks after one monolayer. (auth)

**45781** THE THEORY OF THE ISOMORPHISM OF CERIUM. I. EQUILIBRIUM PHASE p-T DIAGRAM. Aptekar, I. L.; Ponyatovskii, E. G. (Inst. of Solid State Physics, Moscow). Fiz. Metal. Metalloved., 25: 777-86(May 1968). (In Russian).

A theory for the isomorphic phase conversion of cerium is proposed in which the conversion is connected with the changes of the electron state of the ions (transition of the 4f electrons to the conductivity zone). Cerium is considered a pseudobinary system with an uninterrupted series of solid solutions at temperatures above the critical temperature. This makes it possible in the calculation of the phase p-T diagram of cerium to use methods developed for the description of equilibrium in ordinary two-component systems. It is shown that the "pseudobinary" solid solution model is equivalent to the generalized two-level Kittel models. The phase p-T diagram of cerium was calculated, on which, in addition to the equilibrium line of the isomorphous phase ($\alpha'$ and $\alpha$) and the pressure curve, the lines of the stability loss of both phases were plotted. The calculated diagram describes the experimental data well. (tr-auth)

**45782** CROSS NONSTOICHIOMETRY AND VACANCY ORDERING IN THE SYSTEM CERIUM DIOXIDE-YTTRIUM SESQUIOXIDE. Barker, W. W.; Wilson, A. F. (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Inorg. Nucl. Chem., 30: 1415-23(July 1968).

The defect mechanisms occurring in the two major phase regions of the grossly nonstoichiometric system $CeO_2-Y_2O_3$ were studied by a combination of neutron and x-ray powder diffraction, and density measurements. In the rare-earth type "C" oxide region, the random substitution of $Ce^{4+}$ for $Y^{3+}$ cations results in anions entering interstitial sites. This causes the five space group parameters necessary to define the atomic positions to vary continuously as a function of the $CeO_2$ content. In the fluorite-related body-centered cubic phase region, the data show that ordering occurs in the anion lattice. (auth) (UK)

**45783** HIGH RESOLUTION ELECTRON MICROSCOPIC OBSERVATIONS OF THE SUPERSTRUCTURE OF TANTALUM PENTOXIDE. Spyridelis, J.; Delavignette, P.; Amelinckx, S. (SCK-CEN, Mol, Belgium). Mater. Res. Bull., 3: 31-6(Jan. 1968).

High resolution electron microscopic observation of tantalum pentoxide thin films reveals simultaneously lattice fringes due to the superstructure and to the basic structure. The observations support the concept of "shear structures" put forward for this type of crystal by Magnéli and by Wadsley. (auth)

**45784** METASTABLE β-PHASE IN LOW MOLYBDENUM-URANIUM ALLOYS: EFFECT OF THE OVERHEATING RANGE IN THE β-SOLID SOLUTION REGION. Mihajlovic, A.; Mance, A. Bull. Boris Kidric Inst. Nucl Sci., Ceram. Met., 18: No. 3, 412 (Nov. 1967).

The effect of the overheating temperature on quenching U-0.4% and 0.6% Mo alloys from the β-phase region upon the electrochemical behavior of the metastable β-phase was studied by the potentiostatic method. It has been found that neither the lattice deformation due to the quenching nor the precipitates in the β-phase cause change of the dissolution potential and shift of the polarization curves. All these changes are supposed to be caused either by the atom rearrangement in the β-solid solution or by the existence of two crystallographic modifications of the β-phase. (auth)

**45785** DEPENDENCE OF THE MOESSBAUER ISOMER SHIFT ON THE DEGREE OF SPATIAL ORDER FOR COPPER-GOLD ALLOYS. Huray, Paul G.; Roberts, Louis D.; Thomson, J. O. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). pp 596-601 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

In the Cu-Au alloy system, the arrangement of the atoms may be modified by heat treatment. The lattice may thus be highly ordered or may be given various degrees of disorder. By making use of this property and the nuclear monopole interaction, it is possible to explore the charge distribution about individual atoms. The change of electronic charge on the $^{197}$Au atoms which accompanies a change of order in several Cu-Au alloys has been observed through the Moessbauer isomer shift $\Delta E_\gamma$ for $^{197}$Au. A first and second nearest neighbor model is presented to approximately describe the experimental data. (auth)

**45786** ON THE PHASE EQUILIBRIA IN Zr-Nb-Ni TERNARY SYSTEM. Moraleva, A. D.; Sokolovskaya, E. M.; Burnashova, V. V.; Markiv, V. Ya. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 66-70(May-June 1968). (In Russian).

All the compounds formed in the Zr-Ni and Nb-Ni systems were found to be in equilibrium to each other and to solid solutions of Nb and Zr. Isotherms at 500 and 800°C were obtained. (auth)

**45787** INVESTIGATION OF ALLOYS IN Co-$NbCo_2$ SYSTEM. Bataleva, S. K.; Kuprina, V. V.; Markiv, V. Ya.; Burnashova, V. V. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 100(May-June 1968). (In Russian).

The $NbCo_3$ and X phases were proved to exist. The ranges of their homogeneity and temperature of their formation were estimated. (auth)

**45788** STUDY OF CONVERSIONS IN TANTALUM-VANADIUM-TUNGSTEN SYSTEM IN SOLID STATE. Guzei, L. S.; Sokolovskaya, E. M.; Sokolova, I. G.; Vysotskaya, G. V.; Ronami, G. N.; Kuznetsova, S. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 62-5(May-June 1968). (In Russian).

The structure of the Laves phase of $TaV_2$ and its occurrence in the Ta-V-W system were studied. (auth)

**45789** PHASE EQUILIBRIA IN THE SYSTEMS Zr-Re-B AND W-Re-B. Kuz'ma, Yu. B.; Lakh, V. I.; Stadnyk, B. I.; Voroshilov, Yu. V. (Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 6, 47-53(June 1968). (In Russian).

The cast, and quenched at 1500°C, alloys of the systems Zr-Re-B and W-Re-B were investigated by means of x-ray and microscopic methods. A compound with the structure of the β-Mn type (τ-phase, a = 6.809 ± 0.002 Å) was found in the cast alloy with 32 at.% W, 63 at.% Re, and 5 at.% B. In the structure of this compound W and Re atoms are distributed statistically and B atoms fill ¼ of the octahedral holes. Data on the dependence of the lattice constants of W and Re borides on the content of the third component are included. (auth)

**45790** MORPHOLOGY OF INTERSTITIAL AGGREGATES IN IRON. Bullough, R.; Perrin, R. C. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 305: 541-52(July 23, 1968).

A discrete atom model is described for body-centered cubic iron and used to investigate the nucleation and growth of interstitial aggregates. The results provide a consistent explanation of the origin and final orientation of the interstitial loops observed after low-temperature neutron irradiation in α-iron. (auth)

## *Radiation Effects*

*Refer also to abstracts 45750, 45757, and 45790.*

**45791** (BNWL-SA-1835) PRESSURE INDUCED RECOVERY OF IRRADIATION DAMAGE IN MOLYBDENUM. Kulcinski, G. L.; Kissinger, H. E.; Mastel, B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 25, 1968. Contract AT(45-1)-1830. 23p. (CONF-680910-3). Dep. CFSTI.

From International Conference on Vacancies and Interstitials in Metals, Juelich, Germany.

Results of investigations are presented concerning the effects of pressure on annealing of radioinduced defects in Mo. Information is included on the activation volume of the defect involved in the third annealing stage and the effects of pressure on the thermal stability of defect clusters in irradiated Mo. (J.R.D.)

**45792** (BNWL-SA-1996) IRRADIATION-INDUCED EMBRITTLEMENT IN STAINLESS STEEL AT ELEVATED TEMPERATURE. Kangilaski, M.; Perrin, J. S.; Wullaert, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 25, 1968. Contract AT(45-1)-1830. 6p. (CONF-680604-8). Dep. CFSTI.

From Symposium on Radiation Effects to Reactor Metals, San Francisco, Calif.

Results of previously reported research on the irradiation embrittlement of stainless steel are discussed. Theories are advanced to explain stability of gas bubbles in the steel, pinning of grain boundaries, nucleation sites for crack formation, mechanisms of intergranular failures, and the effect of NbC precipitation on high temperature hardening. (P.G.C.)

**45793** (EURAEC-2028) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 8, July 1-September 30, 1967. (Societa Ricerche Impianti Nucleari, Saluggia (Italy)). Mar. 1968. Contract 074-65-10-TEEI(RD). 7p. (EUR-3982). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Measurements were made of the tensile properties of irradiated

and unirradiated Ferrovac E and of unirradiated Fe–Ti alloy specimens at different temperatures and strain rates: the range of strain rates was $1.5 \times 10^{-5} + 4.2 \times 10^{-1}$ sec$^{-1}$. Secondary hardening behavior was checked on unirradiated ASTM A 212 base steels killed with Si, Al, Ti after quenching from 1100°C and tempering at 600°C. Damage dosimetry studies with measurement of the irradiation induced modifications in Ultraperm magnetic properties were continued and some tests were continued. (auth)

**45794** STUDY OF THE SELF-DIFFUSION OF SILVER UNDER CONDITIONS OF ELECTRON IRRADIATION. Bystrov, L. N.; Platov, Yu. M. (Baikov Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved., 25: 844-5(May 1968). (In Russian).

The effect of radiation on the self-diffusion of silver was studied by the absorption method. The diffusion coefficient was determined by the inclination angle of the kinetic line in the coordinates $\ln(I_1 - I_2)/(I_1 + I_2) - t$, where $I_1$ and $I_2$ are the intensities of $\beta$ irradiation on two sides of the sample and t is the annealing time. The samples were irradiated with electrons at 2.0 MeV with current intensity of $3 \times 10^{14}$ electrons/cm$^2$ sec. The study was made at temperatures of 600, 625, 650, 680, 720, 750, and 780°C. The experimental results were processed by the least squares method. No effects of irradiation on the diffusion coefficient were found. (J.S.R.)

**45795** RADIATION HARDENING OF THIN FILMS DURING VACUUM DEPOSITION. Krimmel, E. F. (Univ., Tuebingen, Ger.). Naturwissenschaften, 55: 340(July 1968).

Radiation damage experiments were performed by irradiating a solid with its own ions. An ion source was constructed that enabled the experiments to be carried out simply by studying radiation damage in polycrystalline films of different thicknesses and to compare the results with radiation damage caused by channeling. Aluminum, Ag, Cu, Au, Ni, Pt, Nb, Fe, and Cr films were vacuum deposited on glass substrates at room temperatures. Ions were produced with energies up to 70 keV by ion currents up to 26 mA. Two effects of ion irradiation were observed: increased adhesive strength of the film on the substrate and increased hardness of the film itself. (R.C.K.)

**45796** IRRADIATION AND THE DUCTILITY OF CHROMIUM. Weaver, C. W. (Defence Standards Labs., Melbourne). Scr. Met., 2: 463-6(Aug. 1968).

The effects of neutron irradiation on the mechanical behavior of chromium reveals that although the chromium is hardened by irradiation, the high brittle-ductile-transition temperature (250 to 300°C) is considerably decreased. Tensile specimens were prepared, annealed, irradiated, and tested. A stress-strain curve of neutron irradiated chromium was prepared for 25, 50, and 100°C. (J.C.W.)

**45797** INFLUENCE OF ELECTRON BOMBARDMENT ON ELECTRICAL PROPERTIES OF THIN Te FILMS. Ivankiv, L. I.; Solyanik, Z. V. (Lvov State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 715-6(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 911-13(Mar. 1968).

Thin Te films were bombarded with electrons of energies 50 to 2000 N in a closed bulb initially at $5 \times 10^{-9}$ torr pressure. The bombardment raised the pressure rapidly, and after the bombardment it decreased exponentially to its initial value. A similar effect was observed in the electric resistance, except that heating from prolonged irradiations lowers the final value. Gas analysis using an omegatron showed that the desorbed gas is mainly $CO_2$. The effects of energy on the desorption efficiency ($\sim 10^{-2}$ to $10^{-1}$ molecules/electron) and of electron beam current on the changes are described. (D.L.C.)

**45798** RADIATION RESISTANCE OF ZIRCONIUM ALLOYS WITH 1 PERCENT NIOBIUM IN CM-2 REACTOR. Votinov, S. N.; Guseva, T. M.; Klimenkov, V. I. At. Energy. (USSR), 24: 473-4(May 1968). (In Russian).

Mechanical properties of zirconium alloys with 1% Nb irradiated with up to $6.9 \times 10^{19}$ n/cm$^2$ and up to $1.1 \times 10^{20}$ n/cm$^2$ at 20°C are tabulated. The shock viscosity of unirradiated specimens and specimens irradiated by fast neutrons up to $5.1 \times 10^{20}$ n/cm$^2$ was 6.7 and 6.2 kgm/cm$^2$, respectively. Data obtained on the performance of reactor parts in complex mechanical tension, neutron irradiation, and effects of media proved to be in agreement with published data and confirmed the high resistance of Zr–1% Nb alloy. (R.V.J.)

# Ceramics and Cermets

*Refer also to abstracts 45028 and 45745.*

**45799** (UCRL–18043, pp 155-82) CERAMIC SCIENCE. (Univ. of California, Berkeley).

Results of research are reported on sublimation of $PrF_3$, energy exchange between high-temperature W and gases, vapor species of Ba–O systems, free energy and enthalpy of $Al_2S_3$, and on sublimation of ZnS and CdTe. Research results are also reported on microstructure and behavior of glass and ceramic–metal systems. Work directed toward understanding the relations between the microstructure of ceramic materials and their physical and mechanical properties is described. (J.R.D.)

## Preparation and Fabrication

*Refer also to abstract 45822.*

**45800** (AAEC/TM–439) PREPARATION AND EVALUATION OF AN ADU-DERIVED CERAMIC GRADE $UO_2$ POWDER. Ramm, E. J.; Quaass, S. T. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1968. 38p. Dep.

The method and equipment used to prepare a ceramic grade uranium dioxide powder are described, together with relevant characteristics of the intermediate and final products. The method chosen followed the ammonium diuranate route involving continuous precipitation from uranyl nitrate solution using gaseous ammonia. Conversion of the ammonium diuranate to uranium dioxide was effected by heating in a hydrogen/nitrogen atmosphere and following this with a low temperature stabilisation treatment. Various physical tests were carried out on the resultant powder, and finally, specimens were pressed and sintered over a wide range of pressures and temperatures. The tests indicated that the powder was sinterable and that the method of preparation produced a ceramic grade powder exhibiting consistent properties and behavior. (auth)

**45801** (AAEC/TM–440) HOT PRESSING OF BERYLLIUM OXIDE WITH ADDITIVES. Bardsley, J.; Wulf, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb. 1968. 21p. Dep.

The effect of variations in temperature, pressure, and pressure cycle on the density vs grain size relationship was determined for hot pressed, sulfate-derived UOX beryllium oxide; the effects of selected additives on the final grain size using constant hot pressing conditions were also determined. A single-ended pressing technique, incorporating an incremental build-up in the pressing pressure, was developed to produce hot pressed specimens of near theoretical density with a uniform grain size of 25$\mu$. Smaller grain sizes were not obtained by this technique owing to the onset of discontinuous grain growth at a bulk density of 97 per cent theoretical. However, by introducing an equilibration time at temperature before the application of the load, a theoretically dense specimen (3.010 g/cm$^3$) was produced with a uniform 8$\mu$ grain size. Carbon was the only additive which consistently refined the grain size at all levels of addition. (P.G.C.)

**45802** (AERE-M–1964) THE SINTERING BEHAVIOUR OF $PuO_2$–$ThO_2$. McLaren, J. R. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1968. 7p. Dep. CFSTI. UK.

Results of a preliminary investigation of the sintering and solid solution behavior of mixed $ThO_2$–$PuO_2$ powders showed that sintering in argon at 1600°C provides densities of ~94% of theoretical but poor solid solution formation. Sintering in air or wet hydrogen gives good solid solution formation but poor densification at ~85% theoretical. Dry hydrogen sintering gives low densities with little solid solution. Homogeneous $PuO_2$ distribution was obtained whether or not a solid solution had formed. (auth)

**45803** (GA–8111) SAFE-CREEP: A COMPUTER PROGRAM FOR THE VISCOELASTIC ANALYSIS OF AXISYMMETRIC AND PLANE CONCRETE STRUCTURES. A User's Manual. De Arriaga, F. J.; Rashid, Y. R. (Gulf General Atomic, Inc., San Diego, Calif.). July 31, 1967. Contract W-7405-eng-26; Subcontract No. 2848. 43p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The finite element method is used in the analysis of two-dimensional viscoelastic solids. The program is written in FORTRAN IV language and compiled for the UNIVAC 1108 computer. (J.R.D.)

**45804** (SGAE-M–16/1968) ZUR BESCHICHTUNG VON KERNBRENNSTOFFTEILCHEN MIT PYROKOHLENSTOFF IM WIRBELBETT. (Coating of Nuclear Fuel Particles with Pyrolytic Graphite in Fluidized Bed). Mucha, F.; Koss, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Metallurgie). Apr. 1968. 41p. (In German). Dep.

The factors affecting the structure of the deposited pyrolytic graphite coatings were studied as a function of the fluidized bed temperature, the velocity of the pyrolysis reaction, and the macro- and microgeometry of the fluidized bed. The effects of the total gas velocity on the pyrolytic carbon deposition, py-

rolysis or bed temperature on the kinetics of the pyrolytic carbon deposition in 20 vol.% methane, bed parameters on the pyrolytic carbon properties, bed surface, and methane supply were determined. The bed parameters considered were particle diameter, particle density, charge size, and inhomogeneity. The results obtained are tabulated. A geometrical-chemical scheme for the pyrolytic carbon deposition in fluidized bed is presented. (J.S.R.)

**45805** (UJV-1962) PHASE PURITY CONTROL OF THE SYSTEM U-C-N-O. Benadik, A.; Krivy, I.; Skvor, F. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Apr. 1968. 26p. (In Czech). Dep.

Analytical, x-ray, and metallographic methods of the phase-purity control of UC, UN, and U(C,N,O) are described. The greatest attention was paid to the oxygen (vacuum fusion), the nitrogen (vacuum fusion or Kjeldahl method), the carbon (combustion in oxygen stream at 1100°C), and the uranium determination methods. The lattice parameters of UC ($a = 4.9572 \pm 0.0005$ Å), UN ($a = 4.8907 \pm 0.0005$ Å), and U(C,N) were calculated. The algebraic expression for the lattice constant of the pure carbonitrides in the composition range 0 to 50 mol. % UN was derived. The metallographic examinations gave information about the phase-purity of the materials studied and allowed determination of the free uranium or the metastable uranium dicarbide impurities presented in the amounts 1.5 wt.%.

**45806** (WARD-3791-21) URANIUM-PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending June 30, 1968. Biancheria, A.; Jacoby, W. R. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Aug. 1968. Contract AT(30-1)-3791. 62p. Dep. CFSTI.

Preparation of fuel for the EBR-II irradiation test samples and development of improved characterization techniques for better identification of these samples are reported. Eleven batches of fuel were processed. To aid the preparation of the fuel, investigations were made on several process variables, which included binder additions, reprocessing out-of-specification fuel, and nitrogen impurity. Recent difficulties encountered with nitrogen impurity levels are now believed to be due to analytical techniques. Since the revised irradiation program specified fuels for which there is no previous fabrication experience in the laboratory, development of methods for preparing these fuels is in progress. Stoichiometric fuel has been prepared but densities were too low. Evaluation of etching techniques to improve identification of the structure resulted in reasonable success using a combination of cathodic-vacuum and electrolytic etching. Eight vanadium alloy tensile specimens have been sealed in individual containers and are ready for final sodium loading. A 110-kVA radiographic unit was installed to provide improved sodium-bond characterization. The eddy current equipment was modified to accommodate the testing of longer pins and capsules than heretofore tested. Studies were initiated to determine which steps in the fuel pin assembly process contributed most to the oxygen contamination of sodium. Fabrication was completed and sodium bond tests were initiated for ten mock-up samples of EBR-II test capsules. Nine (U-Pu)C fuel pins continued to function satisfactorily in GETR. Maximum burnup achieved to date exceeds 25,000 MWd/t. Cost and delivery estimates for postirradiation shipping casks were received. Private and government hot cell facility capabilities were reviewed to select those facilities capable of performing the postirradiation examination, for which a formal bid proposal is in preparation. In a program to evaluate the performance of (U-Pu)C fuel pins in a fast flux the detailed nuclear, thermal, and mechanical design of a revised program (16 pins) was nearly completed. (J.R.D.)

**45807** INTERACTING PHASE CONVERSIONS AND ENGINEERING PROPERTIES OF MATERIALS WITH $ZrO_2$-$CeO_2$ BASE. Klyucharov, Ya. V.; Strakhov, V. I. (Leningrad Technological Inst.). Ogneupory, No. 5, 40-3(May 1968). (In Russian).

During slow cooling from high temperatures, partial destabilization of $ZrO_2$ occurs. By the use of this phenomenon zirconium refractory materials with increased thermal stability can be produced. The low tendency to recrystallization of the synthesized tetragonal solid solution does not guarantee the production of the ideal microstructure of the product of its joint annealing with monoclinic $ZrO_2$ which is one of the primary reasons for the low thermal stability of the zirconium articles of this type. (tr-auth)

**45808** FUEL OR BREEDING ELEMENT FOR A NUCLEAR REACTOR. (to Kernforschungsanlage Julich Des Landes Nordrhein-Westfalen e.V.). British Patent 1,121,892. July 31, 1968. Priority date June 29, 1965, Germany.

A reactor fuel element which combines high thermal conductivity and higher specific loadings consists of a vacuum sealed can loosely filled with $UC_2$ fuel particles coated with a many-sided substantially spherical coating of pyrolytic C and/or a carbide or oxide. (P.G.C.)

**45809** INFLUENCE OF NON-STOICHIOMETRY ON THE SINTERING BEHAVIOUR OF URANIA POWDERS. Moorthy, V. K.; Soni, N. C. (Atomic Energy Establishment, Trombay, India). Trans. Indian Inst. Metals, 20: 65-71(June 1967).

The sinterability of oxide powders depends on the physical characteristics of the powders, which in turn depend on the origin and thermal history of the powder. The influence of non-stoichiometry on the sinterability of urania powders has been studied. It was found that the sinterability was promoted by the introduction of non-stoichiometry and sintering in argon atmosphere. A soak in hydrogen for 1 hr after sintering the non-stoichiometric urania pellets to a high density in argon atmosphere, resulted in the elimination of almost all the excess oxygen in the pellets. Urania pellets of high density (97% theoretical) have been obtained by sintering non-stoichiometric powders at temperatures at or below 1020°C. Grain development in sintered pellets was more directly related to the sintering temperature and powder characteristics than to the density attained. (auth)

**45810** PROCESS OF VAPOR COATING NUCLEAR FUEL WITH BERYLLIUM OXIDE AND CARBON. Browning, Melvin F.; Wilson, Wilbur J. (to United States Atomic Energy Commission). U. S. Patent 3,397,075. Aug. 13, 1968.

A process of coating nuclear fuel and blanket materials, such as uranium dioxide particles, comprises the steps of converting a beryllium salt that forms beryllium oxide by hydrolysis, oxidation or pyrolysis, in the vapor state, to beryllium oxide at 800 to 1500°C, incorporating acetylene in the vapor, and contacting the nuclear fuel or blanket material with the vapor to yield a co-deposit of beryllium oxide and 5 to 15 wt % carbon. (AEC)

**45811** TUNGSTEN-RHENIUM COATED CERAMIC REACTOR FUEL PARTICLES. Hamrin, C. E. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,396,080. Aug. 6, 1968.

Spherical ceramic nuclear reactor fuel particles are provided with a uniform bonded coating of tungsten-rhenium metal alloy. (AEC)

**45812** NUCLEAR FUEL MATERIAL AND METHOD OF PREPARATION. Blum, Pierre; Guinet, Philippe; Vaugoyeau, Henri (to Commissariat a l'Energie Atomique). British Patent 1,124,810. Aug. 21, 1968. Priority date Dec. 2, 1964, France.

A nuclear fuel with improved chemical corrosion resistance, thermal conductivity equal to U, and mechanical properties superior to UC or USi, is produced by fusing a stoichiometric, or reaction balanced, mixture of USi and UC, under an inert gas, at approximately 25V and 600A. The fused mass is placed in a mold and arc-melted for about one min at 1000A. The product is a cylinder of homogeneous structure with a uniform dispersion of phases not in equilibrium which is heat-treated at approximately 1650°C for 50 to 100 hr; composition is stated to be $U_3C_3Si_2$. (P.G.C.)

## *Properties Evaluations*

*Refer also to abstracts 45801 and 45808.*

**45813** (AECL-3072) THERMODYNAMICS OF NONSTOICHIOMETRIC URANIUM DIOXIDE. Perron, P. O. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1968. 52p. Dep. CFSTI. CAN $1.50.

A review of the data on the thermodynamics of oxygen in uranium oxides is given. The experimental techniques used in obtaining the data are described and their relative precision discussed. Each measurement involved the determination of the oxygen partial pressure at equilibrium with an oxide of a given oxygen-to-metal ratio. It is believed that the pressure measurements were relatively accurate but that characterization of the oxide phase was difficult and this could have led to appreciable errors in the data for slightly hyperstoichiometric uranium dioxide. Statistical analysis of the data has been carried out and the most probable set of data for hyperstoichiometric uranium dioxide indicated. Similar calculations for hypostoichiometric dioxide were not possible because of the dearth of data. It is shown how the data can prove useful in assisting fuel preparation. The data can also help to explain second-phase particles in uranium oxides and oxygen redistribution during irradiation of oxide fuels. (auth) (Canada)

**45814** (GA-7851) SAFE-PLANE: A COMPUTER PROGRAM FOR THE STRESS ANALYSIS AND DESIGN OF TWO-DIMENSIONAL COMPOSITE BODIES. A User's Manual. Cornell, D. C. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

June 30, 1967. Contract W-7405-eng-26; Subcontract No. 2848. 51p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

A procedure for numerical determination of displacement, strain, and stress composite bodies under either plane strain or plane stress conditions is outlined. (J.R.D.)

**45815** (GEMP-439) CHEMICAL PROPERTIES AND BEHAVIOR OF URANIA ABOVE 1500°C. Fryxell, R. E. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1966]. Contract AT(40-1)-2847. 13p. (CONF-661003-21). Dep. CFSTI.

From AIME Nuclear Metallurgy Symposium on High-Temperature Nuclear Fuels, Delevan, Wis.

The phase diagram for the uranium-oxygen system and related thermodynamic properties are briefly reviewed for the oxygen deficient fluorite structure, $UO_{2-x}$. The nominal environmental equilibrium requirements for maintaining the stoichiometric $UO_2$ composition at high temperatures are discussed. In a hydrogen environment at one atmosphere total pressure, the requisite moisture content varies from about 10 ppM at 1200 to about 100,000 ppM at 2600°C. In an inert gas, the requisite total oxygen varies from about 0.0001 ppM at 1700 to about 100 ppM at 2600°C. The relative effectiveness of various refractory metals as an oxygen barrier to prevent loss of oxygen from stoichiometric $UO_2$ is discussed. The arbitrary criterion of composition change to $UO_{1.99}$ for typical lifetime estimates are obtained for a pure hydrogen environment and a barrier thickness of 0.020 inches (0.051 cm) and are tabulated. Rhenium is a better barrier than Mo, W, or Ta, and W-30Re-30Mo is about the same as pure tungsten. (J.C.W.)

**45816** (NUMEC-3505-27) $PuO_2$-$UO_2$-$ZrO_2$ FUEL DEVELOPMENT PROGRAM. Annual Progress Report, March 1, 1966-February 28, 1967. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Sept. 8, 1967. Contract AT(30-1)-3505. 51p. (EURAEC-1930). Dep. CFSTI.

Work was continued on the development of the $PuO_2-UO_2-ZrO_2$ fuel system. Irradiation testing of six fuel compositions was carried out in the General Electric Testing Reactor. Surface areas of all the $PuO_2-UO_2-ZrO_2$ ceramic-grade powders prepared by coprecipitation and mechanical blending were determined using the krypton B.E.T. technique. Addition of $ZrO_2$ to $PuO_2-UO_2$ raised the surface areas of the coprecipitated ternary oxides by factors of 2 to 8 as compared with the normal value of ~6 $M^2/g$ obtained for binary $PuO_2-UO_2$ powders prepared by the same process. For mechanically mixed powders, the corresponding values were 7 to 9 and 3 to 5 $M^2/g$. Reference lattice parameter data were obtained for all compositions prepared by the coprecipitation process. Data indicated that controlled oxidation introduced no gross structural changes in the four compositions that were initially single-phase fcc. However the two high-$ZrO_2$ content materials showed marked changes in structure. Low- and intermediate-$ZrO_2$ content samples exhibited single-phase structure, while the high-$ZrO_2$ content samples contained a second phase. The second phase was identified with nonstructured large grains in a fine-grained matrix. (M.C.G.)

**45817** GRAPHITIC MATERIALS HOT-WORKED WITH A DISPERSED LIQUID CARBIDE: THERMAL AND ELECTRICAL CONDUCTIVITY. White, J. L.; Koyama, K. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. J. Amer. Ceram. Soc., 51: 394-8(July 21, 1968). (GA-7437).

Graphitic materials produced by hot-working with a dispersed liquid-carbide phase (termed HWLC graphites) have high thermal and electrical conductivities compared with hot-worked or conventional graphites prepared without additives. Thermal diffusivity and electrical conductivity were measured at room temperature on two HWLC materials containing either molybdenum carbide or zirconium carbide. This process of liquid-phase sintering with compressive deformation imposes a strong preferred orientation on the predominantly graphitic material, and the resulting thermal conductivity in the preferred direction of the layer planes is greater than the thermal conductivity of copper or silver. Thus, liquid-phase stress sintering induces in graphitic materials an essentially new microstructure that provides a means of realizing the inherent high thermal conductivity of the graphite layer plane in a massive body. (auth)

**45818** THERMAL CONDUCTIVITY AND HEAT CAPACITY OF THE MONOPHOSPHIDE AND MONOSULFIDE OF PLUTONIUM. Moser, J. B.; Kruger, O. L. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 51: 369-72(July 21, 1968).

The thermal properties of PuP and PuS were measured from room temperature to 650°C by a heat-pulse technique. Disk-shaped specimens of 90% theoretical density were made by isostatic cold-pressing and sintering. The thermal conductivity of PuP corrected to theoretical density ranged from 0.014 cal $sec^{-1}$ $cm^{-1}$ $°C^{-1}$ at room temperature to 0.019 at 650°C. Over this temperature range the heat capacity increased from 0.055 to 0.056 cal $g^{-1}$ $°C^{-1}$. The thermal conductivity of PuS decreased approximately 16% from its room temperature value of 0.023 cal $sec^{-1}$ $cm^{-1}$ $°C^{-1}$ and then rose to 0.037 at 650°C. The temperature dependence of the thermal conductivity of PuP is apparently related to the quasimetallic electrical properties of this compound. PuS is a semiconductor and the rise in its thermal conductivity (after passing through a minimum) may be partly attributed to a bipolar thermal diffusion mechanism. (auth)

**45819** EFFECT OF THE DENSITY ON THE CHANGE OF THE STABILITY OF REFRACTORY MATERIALS. Prantskyavichyus, G. SA. (Inst. of Power and Electrical Tech., Vilnyus, USSR). Ogneupory, No. 5, 45-9(May 1968). (In Russian).

It was experimentally established that the scattering of the values of the stability of the oxide refractory materials was caused by scattering of the apparent density. This phenomenon was impossible to observe separately from the characteristics of the density. For a separate series of samples there was a direct connection between the individual values of the apparent density and the limits of the density during contraction and expansion. In the explanation of the difference of the density indices of the refractory materials random factors do not have a decisive effect. (tr-auth)

**45820** INFLUENCE OF ATMOSPHERE ON DENSIFICATION DURING SINTERING OF $UO_2$. Kostic, Emilija. Bull. Boris Kidric Inst. Nucl Sci., Ceram. Met., 18: No. 1, 1-6(Oct. 1967).

Results of investigation of atmospheric effects on the densification of uranium dioxide powders during sintering are presented. The rate of this process changed in the relation $(\Delta V/V_0) = k\,t^n$, where n depends on the kind of gas used. The experimental temperature ranged from 1300 to 1550°C (0 to 8 hr). Helium, hydrogen, and vacuum were used to avoid oxidation. It has been proved that the highest densities of sintered samples of uranium dioxide powders, and optimal microstructure are obtained in helium. (auth)

**45821** GASEOUS METAL NITRIDES. II. THE DISSOCIATION ENERGY, HEAT OF SUBLIMATION, AND HEAT OF FORMATION OF ZIRCONIUM MONONITRIDE. Gingerich, Karl A. (Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys., 49: 14-18 (July 1, 1968).

The ZrN molecule has been identified in the vapor phase over a ZrN-BN mixture at temperatures above 2400°K using a combination of effusion and mass spectrometric techniques. Its appearance potential was measured as 7.9 ± 0.4 eV. From the experimentally determined partial pressures, the equilibrium constants and the enthalpy for the gaseous reaction $ZrN = Zr + 0.5\,N_2$ have been calculated. The reaction enthalpy was obtained as $\Delta H^0_{298}$ = 22.0 ± 5.0 kcal/mole. Combined with published thermodynamic data this reaction enthalpy yields the following thermodynamic properties for gaseous ZrN: $ZrN(g) = Zr(g) + N(g)$, $D^0_{298} = 135.0 \pm 6.0$ kcal, $ZrN(s) = ZrN(g)$, $\Delta H^0_{s,298} = 211.4 \pm 9.0$ kcal, $Zr(s) + 0.5N_2(g) = ZrN(g)$, and $\Delta H^0_{f,298} = 123.5 \pm 7.0$ kcal. (auth)

**45822** DEVELOPMENT OF A GRAPHITE (HX30) WITH IMPROVED GAS DIFFUSIONAL CHARACTERISTICS. Longstaff, B.; Jenkins, T. R.; Morris, J. B.; Graham, L. W. (Atomic Energy Establishment, Winfrith, Eng.). J. Appl. Chem. (London), 17: 172-9(June 1968).

The specification of a graphite suitable for DRAGON reactor fuel tubes, which operate on the "back-sweep" purge principle, includes the two requirements that the viscous permeability constant $B_0 < 3 \times 10^{-11}$ $cm^2$, and that the fission-gas transmission coefficient $D' < 1 \times 10^{-6}$ $cm^2/sec$ at 20 atm, 750°C, and 2 psi pressure drop. Calculations, based on the results of a study of the counter-diffusion of gases in graphite, suggested that, providing the first criterion was satisfied, the second requirement would be met by a material whose pores were on the average at least 5.5 μm in diameter. A series of experimental graphites based on grists of scrap nuclear-grade graphite was made with the object of producing artefacts whose pore sizes were in the region of 10 μm, without exceeding the specified limit on permeability. After several adjustments to the size distribution a grist was obtained which yielded an artefact which, after subsequent pitch impregnation, satisfied the reactor specification. The family of graphites based on this particular grist is known as HX30. A second series of experiments demonstrated that this material could be made in full-sized rods 8 ft long by 3.25 in. dia. Any of four baking routes was possible, depending on whether the primary bake and the re-bake after impregnation were carried out under atmospheric pressure or at 100 psig. An appropriate number (1 to 3) of impregnations yielded an acceptable graphite. The superior properties of HX30 are considered to be due chiefly to the exclusion of fines (below 300 BSS mesh) from the grist, but

the nature of the grist (graphite and not coke) and the use of re-extrusion are probably also significant. The original theoretical approach appeared to be largely vindicated by the pore-size distribution of the successful product. (auth) (UK)

### *Structure and Phase Studies*

**45823** (NSJ-tr-124) ON THE MICROSTRUCTURE CHANGE INDUCED BY CENTER MELTING AND THE FORMATION OF CENTRAL VOIDS IN POWDER COMPACTED $UO_2$ FUEL. Kubota, Tadashi; Seki, Yoshinobu; Takahashi, Shuichiro. Translated from Nippon Kinzoku Gakkaishi, 31: 406-12(1967). 16p. Dep.

This report was abstracted from the original language and appeared in NSA as 21: 34966. (R.C.K.)

**45824** GRAIN GROWTH IN $UO_2$–$Al_2O_3$ IN THE PRESENCE OF A LIQUID PHASE. Lay, K. W. (General Electric Research and Development Center, Schenectady, N. Y.). J. Amer. Ceram. Soc., 51: 373-6(July 21, 1968).

The theory of grain growth in the presence of a liquid phase is examined using modifications of equations derived for coalescence of solid particles widely dispersed in a liquid. Although the grain diameter-time relation can still be represented by $d^3 = kt$, the absolute growth rates are increased as the amount of liquid is decreased. The grain growth kinetics in $UO_2$ compacts containing 0.5 wt % $Al_2O_3$ were studied for temperatures between 1960 and 2200°C. The interrelation of grain size, temperature, and time is in agreement with that predicted by the theory. (auth)

**45825** INVESTIGATION OF THE KINETICS OF THE PHASE CONVERSION OF ZIRCONIUM DIOXIDE AND CUPRIC OXIDE SAMPLES DURING ANNEALING. Bessonov, A. F.; Taksis, G. A. Ogneupory, No. 5, 53-5(May 1968). (In Russian).

The phase conversion of zirconium dioxide and cupric oxide samples was investigated during annealing up to 1500°C. The studies were made on an installation for simultaneous high-temperature plotting of roentgenograms, thermograms, and electroresistance curves. (tr-auth)

**45826** PHASE EQUILIBRIUM ANALYSIS OF THE $UO_2$–$V_2O_5$ SYSTEM IN TEMPERATURE INTERVAL 900 TO 1200°C. Herak, Rajna M.; Manojlovic, Ljubica M.; Knezevic, Gordana M. Bull. Boris Kidric Inst. Nucl. Sci., Ceram. Met., 18: No. 2, 7-10(Nov. 1967).

Phase equilibrium in the $UO_2$–$V_2O_5$ system was studied by x-ray analysis of samples covering a wide concentration range, heated at 900, 1000, 1100, and 1200°C in an argon atmosphere. Compounds of the compositions $UVO_5$, $UV_3O_{10}$ were identified. (auth)

**45827** SOLID STATE REACTIONS FORMING THE (Pb,Sr) (Ti,Zr)$O_3$ SOLID SOLUTION. Harris, Norman Howard. Urbana, Ill., Univ. of Illinois, 1967. 82p.

Thesis.

The reactions forming the (Pb,Sr) (Ti,Zr)$O_3$ solid solution were studied using differential thermal analysis, thermogravimetric analysis, x-ray diffraction and chemical analysis. The net reactions forming the Pb(Ti,Zr)$O_3$ solid solution from the polycrystalline mixture of PbO + $TiO_2$ + $ZrO_2$ (2 : 1 : 1 mole ratio) were reported previously. The role of strontium substitutions for lead was observed in the present study to form intermediate solid solutions such as (Pb,Sr)$TiO_3$ and (Pb,Sr)$ZrO_3$. Due to the complexity of the reactions involved it was not possible to determine the relative proportions of one or the other strontium solid solutions formed. However experimental results indicated that the formation of the (Pb,Sr)$TiO_3$ solid solution was favored. Weight loss studies for the formation of the solid solution $Pb_{1-z}Sr_zTi_{0.46}Zr_{0.54}O_3$, where z = 0, 0.03, 0.06 and 0.09, indicated that at 850°C the time required for complete reaction of the $SrCO_3$ increased with increasing strontium concentrations. The formation of the (Pb,Sr) (Ti,Zr)$O_3$ solid solution was demonstrated by differential thermal analysis to produce some liquid PbO phase and thus did not proceed through a true solid state reaction. Thermodynamic calculations indicated the mechanism of reaction of $SrCO_3$ + $TiO_2$ (1 : 1 mole ratio) was by formation of a compound. SrO was not formed as an intermediate step. Samples heated 6 hours at 950°C were examined by x-ray diffraction at 25°C and exhibited the presence of $SrCO_3$, $TiO_2$ and $SrTiO_3$. However samples heated 6 hours at 1100°C showed the presence of $SrCO_3$, $TiO_2$, $SrTiO_3$, $Sr_2TiO_4$, $Sr_3Ti_2O_7$ and $Sr_4Ti_3O_{10}$. The PbO + $TiO_2$ reaction was studied with a PbO vapor-$TiO_2$ single crystal system and formation of a product layer was observed on both sides of a platinum wire marker. The product layer was determined by Debye–Scherrer x-ray diffraction camera to contain only $PbTiO_3$. This result indicates that $PbTiO_3$ was formed by a counter diffusion of $Pb^{2+}$ and $Ti^{4+}$ ions instead of by PbO migration into $TiO_2$ as reported. (Disser. Abstr.)

**45828** ROENTGENOGRAPHIC INVESTIGATION OF THE SYSTEM $MoO_3$–$WO_3$. Semikina, L. E.; Limonov, V. E. Zh. Neorg. Khim., 13: 1932-5(July 1968). (In Russian).

The system $WO_3$–$MoO_3$ was investigated in the limits from 0 to 100 wt % $MoO_3$ by powder x-ray methods. Three types of roentgenograms, corresponding to the different compositions of the samples, were obtained. It was assumed that the three types of roentgenograms correspond to three chemical compositions of $WO_3$ with $MoO_3$. (tr-auth)

### *Radiation Effects*

*Refer also to abstracts 45806 and 46246.*

**45829** (EURFNR-503) INVESTIGATION OF IRRADIATION DAMAGE IN $ZrO_2$ ZrC AND $UO_2$, UN AND UC BY X-RAY DIFFRACTION. Dienst, W.; Brucklacher, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translated from report KFK-745. 27p. (EUR-3711). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Powder samples of $ZrO_2$ (cub. stable), ZrN, ZrC and UN, UC were irradiated in reactor FR 2 (Karlsruhe) at temperatures below 150°C to integrated fast neutron flows of $2.5 \cdot 10^{19}$ n/cm² (E > 100 keV) or up to fission densities of $6.4 \cdot 10^{18}$ f/cm³. With a röngten counter tube goniometer for radio-active samples the changes in the lattice constants ($\Delta a/a \approx 1 - 5 \cdot 10^{-3}$) caused through irradiation and the x-ray reflection widths were determined. It was possible to connect the differences in the $\Delta a/a$ saturation course for the zircon compounds with the fact that the resistance against the formation of large inter-lattice atom clusters increases during the transmission from predominantly ion to co-valent combination. The investigation results so far permit the supposition that the mobility of the point defects in the lattice of the uranium compounds in the order $UO_2 \rightarrow UC \rightarrow UN$. (auth)

**45830** REFINEMENT OF THE CRYSTAL STRUCTURE OF HEAT-TREATED MONAZITE CRYSTAL. Ghouse, K. M. (Regional Research Lab., Hyderabad, India). Indian J. Pure Appl. Phys., 6: 265-8(June 1968).

Refinement of the crystal structure of monazite crystals heated at 1130°C for a sufficiently long period has been carried out using successive difference Fourier syntheses. It is concluded that the disorder in the lattice caused by α-particles from thorium is not rectified even after heating. From the sharpness of x-ray reflections obtained from the heated sample, it is concluded that in the process of heat treatment, some rearrangement of the structure takes place. (auth)

**45831** METHOD AND APPARATUS FOR DETERMINING COOLING AGE OF NUCLEAR REACTOR FUEL. Moulthrop, Homer A. (to United States Atomic Energy Commission). U. S. Patent 3,398,280. Aug. 20, 1968.

A method and apparatus are described for determining the period of time which irradiated fuels have been allowed to age since their removal from a nuclear reactor by comparing the gamma count rate of an isotope having a relatively long half-life with a gamma count rate of an isotope having a relatively short half-life. (AEC)

**45832** REDUCTION IN THE COEFFICIENT OF LINEAR THERMAL EXPANSION OF GRAPHITES ON HIGH-TEMPERATURE IRRADIATION TO HIGH-NEUTRON DOSES. Fitzer, E.; Fritz, W.; Delle, W. (Univ., Karlsruhe, Ger. Kernforschungsanlage, Juelich, Ger.). Carbon, 6: 273-5(May 1968). (In German).

Different graphite types were irradiated in the Dounreay Fast Reactor at a temperature of about 1200°C to a neutron dose between 3.6 and $6.3 \times 10^{21}$ nvt ($E_n$ > 0.11 MeV). Under these irradiation conditions the coefficient of linear thermal expansion (CTE) decreased to about 40 to 85% of its original value. A possible explanation for the decrease of the CTE during high temperature irradiation to high doses is given. (auth) (UK)

## Plastics and Other Materials

*Refer also to abstracts 45029, 45212, and 45745.*

**45833** ELASTOMER SEALS FOR HIGH PRESSURE $CO_2$. Nucl. Eng., 13: 586-90(July 1968).

Sealing problems encountered with butadiene–acrylonitrile copolymer joints, during tests on a mock-up for the $CO_2$-cooled EL-4 reactor prototype, led to a study of other elastomers, and attempts to develop suitable new ones. At 60 bars pressure and ambient temperature the elastomer absorbed $CO_2$, which on de-

compression caused massive inflation of the joint. Theoretical considerations of the physico-chemical phenomena involved resulted in a series of tests which recorded dimensional variations with time, for various mixtures, taking into account temperature and a well-defined pressure cycle. Encouraging results were obtained with a silicon ethylene–propylene type polymer, gamma irradiated to improve creep resistance. Tests of longer duration are continuing. (UK)

# PHYSICS (GENERAL)

## Astrophysics and Cosmology

*Refer also to abstracts 46519, 46521, and 46528.*

**45834** (N-68-23074) ON THE ASYMPTOTIC BEHAVIOR OF SOLUTIONS OF EQUATIONS FOR STATIONARY SPHERICO-SYMMETRICAL OUTFLOW OF PLASMA FROM THE SUN. Konyukov, M. V. Translation of Ob Asimptoticheskom Povedenii Resheniy Uravneniy Statisionarnogo Sfe Richeski Simmetrichnogo Istecheniya Plazmy Iz Solntsa, Moscow, Academy of Sciences, 1967, Preprint No. 148. 10p. (NASA-CR-94511; ST-PP-SP-10709). CFSTI.

The asymptotic behavior is found for the solution of equations of stationary spherico-symmetrical outflow of plasma from the sun, at a substantial role of viscosity and heat conductivity. The expressions obtained for the principal terms of expansion point to the existence in the hydrodynamic velocity of irregular asymptotes, which differ essentially from the principal terms of expansions found by various authors. The causes of such a discrepancy are discussed. (auth) (STAR)

**45835** (NRC-TT-1323) RADIO OBSERVATIONS OF THREE SUSPECTED TYPE II SUPERNOVA REMNANTS. Bystrova, N. V.; Gosachinskii, I. V.; Egoroga, T. M.; Ryzhkov, N. F. Translated by H. R. Hayes (National Research Council of Canada, Ottawa), from Izv. Gl. Astron. Observ. v Pulkove, 24: 202-5(1965). 9p. Dep.

The results are given of observations of the extended nonthermal radiosources W44, W28, W14, made with the Pulkovo large radio telescope. The polar diagram at the declinations of the sources is $7' \times 1.5°$, $7' \times 4.5°$ and $7' \times 0.8°$, respectively, at 21-cm wavelength. The brightness distribution in the continuum along the sources is not in agreement with the space model assuming a thin spherically symmetric shell. Transit curves in some frequencies of the neutral hydrogen line profile are given. The possible upper limit of the distance to the sources is estimated. (auth)

**45836** (TID-24666, pp 1-6) SEARCH FOR CONTINUOUSLY CREATED HYDROGEN. Cohen, S. A.; King, J. G. (Massachusetts Inst. of Tech., Cambridge).

An experiment designed for continuously creating hydrogen is described, and results are discussed. (M.O.W.)

**45837** THE MASS-LUMINOSITY RELATIONSHIP AND THE HELIUM CONTENT OF THE MEMBERS OF THE HYADES CLUSTER AND OTHER YOUNG STARS. Alexander, J. B. Quart. J. Roy. Astron. Soc., 9: 136-58(June 1968).

The masses of six visual binaries in the Hyades cluster are discussed. The quality of the observations does not permit an accurate determination of the mass-luminosity relationship of the cluster itself. No evidence is found for any difference between the mass-luminosity relationships of the Hyades and Sirius moving groups. However, it appears that young main-sequence stars (including those in these two moving groups) are undermassive when compared with older main-sequence stars of the same luminosity. This fact and other considerations strongly suggest that the fractional helium abundance of the interstellar gas has increased by some fifty percent or so since the Sun was formed. (auth) (UK)

**45838** THE NEUTRINO ENERGY EMISSION OF STARS TAKING INTO ACCOUNT THE PAULI PRINCIPLE. Pinaev, V. S. Dokl. Akad. Nauk SSSR, 178: 317-20(1968). (In Russian).

A criterion is obtained for the establishment of thermodynamic equilibrium of neutrinos in a star. It is assumed that the neutrino (or antineutrino) concentration is constant, the neutrino flux is homogeneous and isotropic, and the density and temperature of the material are constant with respect to radius. When the occupation number $f \ll 1$, the neutrino path is much greater than the dimensions of the star $1 \gg R$, and the neutrino emission has a volume nature. Instead of the neutrino energy flux, the neutrino energy losses from a unit volume per unit time are introduced. The upper limit of the masses of collapsing stars in which neutrino equilibrium can be established is determined. (ATD)

**45839** DISCOVERY OF HYDROXYL RADIO EMISSION FROM INFRARED STARS. Wilson, William J.; Barrett, Alan H. (Massachusetts Inst. of Tech., Cambridge). Science, 161: 778-9(Aug. 23, 1968).

Radio spectral line emission from hydroxyl radicals has been detected from four infrared stars. The emission from the infrared star NML Cygni at 1612 MHz is the strongest radio emission line yet detected. Sixteen other stars with infrared excesses showed no detectable hydroxyl radio emission. (auth)

**45840** SOLAR WIND AND THE INTERPLANETARY MAGNETIC FIELD. Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). Astronaut. Aeronaut., 5: 8-16(Oct. 1967).

The study of the interplanetary medium began with the investigation of characteristic world-wide but extremely small (<1%) disturbances of the geomagnetic field following intervals of solar activity, referred to as magnetic storms and in general identified as individual transient events associated with specific solar activity. Several types of magnetic storms are known to exist according to their characteristic temporal signature and frequency of occurrence. One is the classic sudden-commencement magnetic storm (SC) generally associated with visible solar-flare activity. An extended synoptic study of the interplanetary sector structure has been possible. The quasistationary 4-sector structure observed in early 1964 was evolutionary with new sectors appearing and others disappearing during 1965. Definitive measurements of the positive-ion spectrum have been obtained in several satellite programs (Mariner, IMP, EGO, Pioneer, and Vela). The principal constituent is hydrogen, with ~5% He present. Helium percentage varies in a way not yet understood. A detailed study of the direction of arrival of the solar plasma at 1 AU indicates an angular departure from radial flow of ~1.5° east of the Sun, in the sense of a corotating corona. These observational results have been anticipated in theoretical studies. Correlative studies of low-energy solar cosmic-ray anisotropy (protons ~14 MeV) and the interplanetary magnetic field have been performed from Pioneer 6. Immediately following a solar flare, the cosmic-ray anisotropy is frequently 20 to 50% and the direction is closely aligned with the local interplanetary magnetic field. Present programs of NASA include a continuing series of IMP and Pioneer spacecraft to monitor the interplanetary medium near 1 AU for the next several years. At present Pioneer 6 and 7 are actively transmitting data at differential heliocentric longitudes of ~65° and ~40°, respectively. The reception of data from these satellites has been limited as they moved progressively further from the Earth. From geocentric orbits several satellites in the IMP and EGO series are measuring properties of the interplanetary medium when they go sufficiently far from the Earth. Simultaneous data are now being obtained from Explorer 33, 34, and 35. Explorer 35 is in a selenocentric orbit and monitoring the interplanetary medium when the Moon itself is outside of the influence of the Earth and its magnetic tail. (BBB)

**45841** COLLECTIVE EFFECTS IN STELLAR DYNAMICS AND PLASMA PHYSICS. Hohl, Frank. Williamsburg, Va., Coll. of William and Mary, 1967. 282p.

Thesis.

The major part of the thesis is concerned with the stability and evolution of stellar systems. One- and two-dimensional models are used to perform computer experiments tracing the evolution of stellar systems. The stationary solution of the Vlasov equation for a one-dimensional system of stars as computed for an interesting class of initial conditions is found to correspond to a minimum-energy configuration. The results of the numerical experiments are compared with theory. For initial energies far from the minimum equilibrium energy the system becomes unstable and breaks up into smaller clusters. A variational principle has been applied to the one-dimensional stellar system to show that stationary distribution functions which decrease monotonically in going outward from the center of the system are stable. Other stationary distributions may be unstable as is illustrated by means of computer experiments. The one-dimensional model is of interest as an approximation to the distribution of velocity and mass normal to the galactic plane of a highly flattened galactic system. Observational results for the gravitational force normal to the galactic plane of our Galaxy agree with the results obtained from the one-dimensional model. Numerical experiments with a simple two-dimensional rod model show that the spiral structure and other filamentary structure of galaxies may result from purely gravitational effects. The minimum energy property investigated for a one-dimensional stellar system is found to apply also to a plasma. Numerical experiments are performed to confirm the theoretical results. In investigating the quasi oscillations of electrons near a sharp plasma boundary it is found that crossings of electron sheets occur which destroy the initially cold plasma oscillations. The rate at which the disturbance penetrates into the plasma and causes thermalization of the initially cold plasma oscillations is investigated by means of computer experiments with a one-dimensional sheet model. The effect of a transverse magnetic field on the thermalization is studied. (Diss. Abstr.)

**45842** RAPID CONTRACTION OF A PROTOSTAR TO THE STAGE OF QUASI-HYDROSTATIC EQUILIBRIUM. I. THE CASE

OF ONE SOLAR MASS WITHOUT RADIATION FLOW. Nakano, Takenori (Kyoto Univ.); Ohyama, Noboru; Hayashi, Chushiro. Progr. Theor. Phys. (Kyoto), 39: 1448-67(June 1968).

The evolution of an opaque protostar of one solar mass was investigated up to the onset stage of quasi-hydrostatic equilibrium by solving numerically the hydrodynamic equations of motion. The protostar was assumed to retain spherical symmetry. The dissipation of the energy of mass motion by shock waves was taken into account, but the radiation flow in the protostar was neglected because of the rapidity of the dynamics. It was found that the stellar structure at the onset stage of quasi-hydrostatic equilibrium is insensitive to the initial distributions of density and temperature in the protostar. At this onset stage the star has an isothermal and dense core and a tenuous envelope with a radius of about 200 $R_\odot$. By the shock wave an outermost envelope having a mass as small as $10^{-4}$ $M_\odot$ is ejected from the star. (auth)

**45843** EVOLUTION OF CARBON STARS. II. CARBON BURNING PHASE. Sugimoto, Daiichiro; Yamamoto, Yoshiaki; Hoshi, Reiun; Hayashi, Chushiro (Nagoya Univ., Japan. Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1432-47(June 1968).

The stage of the zero-age carbon main-sequence and the subsequent evolution due to the depletion of carbon were studied for carbon–oxygen stars, which are regarded as representing the carbon–oxygen cores of ordinary stars having hydrogen and helium envelopes. The structure in the zero-age stage was computed for several stellar masses between a minimum value and 40 $M_\odot$, and the evolution was computed for the masses, 1.0, 2.6, and 10.0 $M_\odot$. These computations were made for the two alternative cases, with and without neutrino loss. It was found that the neutrino loss reduces the lifetime of the carbon-burning phase at least by a factor of 30. By reference to the preceding study of the gravitational contraction phase, the lifetime of an ordinary star of 15.6 $M_\odot$ as a red supergiant was obtained. The time of evolution without neutrino loss is consistent with the observed numbers of red supergiants in the star clusters, h + $\chi$ Persei and NGC 330, but the evolution with neutrinos is faster by a factor of 20. Finally, the effects of rotation, helium flicker, and mass loss on the lifetime are discussed. It seems unlikely that these effects are large enough to increase the lifetime by a factor as large as 20. (auth)

**45844** POSITIONS OF FOUR PULSARS. Turtle, A. J.; Vaughan, A. E. (Univ. of Sydney). Nature (London), 219: 845-6(Aug. 24, 1968).

Accurate positions of the four pulsars CP 0950, 1133, 1919, and 0834 were measured with the one mile cross type radio telescope at the Molonglo Radio Observatory, operating at 408 MHz. Experimental methods are described, and results shown in tabular and graphical form. The declination of CP 0834 was not measurable. CP 0950, possibly the nearest of these pulsars, shows no optical features, suggesting a very low intrinsic luminosity. (UK)

**45845** SCALAR INTERACTION IN SUPERDENSE MATTER. Kalman, G. (Brandeis Univ., Waltham, Mass. Air Force Cambridge Research Labs., Bedford, Mass.). Ann. Astrophys., 31: 353-4(May-June 1968).

The problem raised by Pacini (1966), whether the superdense matter interacting through a scalar field can have negative energy density is re-examined: it is pointed out that because of the effective momentum dependence of the scalar interaction such a negative energy state can never arise. (auth)

**45846** CONVECTIVE INSTABILITY IN A GASEOUS STAR. Tassoul, Monique; Tassoul, Jean-Louis (Princeton Univ., N. J.). Ann. Astrophys., 31: 251-6(May-June 1968). (In French).

The stable and unstable gravity modes of a gaseous star consisting of convective regions separated by radiative zones are considered. Applied to the first order, Oliver's asymptotic technique shows that, for each superadiabatic (subadiabatic) region, there corresponds one unstable (stable) frequency spectrum. Unstable oscillations remain confined to convectively unstable regions and overshooting in the surrounding medium is negligibly small. (auth)

**45847** THEORY OF STELLAR CLASSIFICATIONS. II. DEVIATIONS FROM L.T.E. IN THE CONTINUUM. Feautrier, P. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 257-68(May-June 1968). (In French).

A new numerical method for solving the transfer equation is applied to the construction of model stellar atmospheres in radiative and hydrostatic equilibrium, but not in local thermodynamic equilibrium (LTE). The first two models are for rather hot main-sequence atmospheres and allow for departure from LTE in the first ten levels of neutral hydrogen. The visible continuous spectrum is not modified very much by these departures; however, the models predict a temperature rise in the outer layers of the atmosphere. Another model has a solar effective temperature and gravity. It allows for departure from LTE for the negative hydrogen ion. It predicts a temperature plateau in striking similarity with the Bilderberg Continuum Atmosphere. (auth)

**45848** STUDY OF $\tau$ BOOTIS AND COMPARISON BETWEEN METAL ABUNDANCES IN 15 F AND G STARS. Spite, M. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 269-91(May–June 1968). (In French).

The strictly differential method, explained in the two preceding papers about $\chi$ Draconis and $\gamma$ Serpentis, was used to find with good accuracy the abundances of various elements in the atmosphere of the metal-rich star $\tau$ Bootis. The chemical compositions of these three stars were then compared. It was found that, when the abundance of metals (relative to hydrogen) increases, the ratio Mn/Fe increases while the Ca/Fe and Ti/Fe ratios decrease; moreover, the Ca/Fe ratio decreases more quickly than the Ti/Fe ratio. These laws are confirmed by the study of all precise abundance determinations of F–G type stars found in the literature. The most probable explanation of the variations of the abundance of these three elements is presently a very small but systematic variation of the physical conditions in which these elements were produced by nucleosynthesis in supernovae. The reasons for these systematic variations are yet to be found. Another explanation is a differential sedimentation of interstellar grains. The latter would be favored if the presumed overdeficiency of carbon in metal deficient stars was confirmed. (auth)

**45849** DIFFERENTIAL ROTATION. Occhionero, F. (Laboratorio di Astrofisica, Rome). Ann. Astrophys., 31: 345-7(May-June 1968).

A recent paper [Dicke, 1967] presented a particular solution for the problem of differential rotation in laminar, nonviscous flow: a few general words of comment are added, on an exemplificative model and on the stability analysis. Specific numerical applications are left for further research. (auth)

**45850** NARROW- AND BROAD-BAND PHOTOMETRY OF RED STARS. II. DWARFS. Eggen, Olin J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena. Australian National Univ., Canberra). Astrophys. J., 16: Suppl. Ser., No 142, 49-96(Aug. 1968).

Broad-band (UBV) and narrow-band (RI) (102, 65, 62) photometry of 500 M dwarfs is discussed. The sample contains about 90% of the stars brighter than visual magnitude 10 found in the McCormick (Vyssotsky) discovery lists, as well as 10% of the fainter stars and an additional 100 stars not included in these lists but for which radial velocities and proper motions are known. The ($M_V$, R–I) and M(102), (102, 65) relations for all populations show little dispersion for the stars with color temperature greater than about 4000°K. These relations for the young disk population show little dispersion over the whole temperature range observed, but the meager data available for the halo population indicate that those cooler than about 4000°K are displaced more than a magnitude below these relations. The majority of the old disk-population stars lies on the color–luminosity relations of the young disk population, but some representatives are displaced below these relations by amounts that range up to those found for the halo-population stars. An obvious explanation for these displacements is that they are caused by an effect of the chemical composition on the stellar opacities, and this effect is temperature-dependent. The agreement in the ($M_V$, R–I) relations for eight Hyades cluster dwarfs and for stars with parallaxes greater than 0.125'' leaves little room for the speculation that the cluster parallax is seriously in error. The TiO bands in the dwarfs have similar strength to those in the giants to color temperatures near 3800°K, but for cooler stars they block approximately 20% more radiation at a given temperature. A few stars, including members of the halo population, show large displacements below the normal (102, 65), (65, 62) relation, but the explanation may be other than the obvious one of larger than normal TiO absorption. Space motions of all 500 stars are discussed with reference to moving groups and to the presence of hydrogen emission. The stars are almost evenly divided between young and old disk populations and include, at most, a dozen members of the halo population. (auth)

**45851** ABUNDANCES IN K-GIANT STARS. II. A SURVEY OF FIELD STARS. Helfer, H. L. (Univ. of Rochester, N. Y.); Wallerstein, George. Astrophys. J., 16: Suppl. Ser., No. 141, 1-48(Aug. 1968).

Metal abundance determinations based on curve-of-growth analyses are given for twenty-seven early K-giant stars. Relations giving the dependence of B–V and U–B of the UBV system upon metal abundance are given; the temperature calibration being provided by the G, R, and I colors of the six-color

photometry. Mass estimates, with an uncertainty of a factor of 2, are derived from the spectroscopic analyses and K-line absolute magnitudes. Loci of constant mass in the temperature-luminosity diagram may be crudely determined. There exists a group of K giants very much less massive than the Hyades K giants; there is some evidence that these stars may have subsolar masses. The abundance analyses themselves reveal the existence of a group of stars overabundant in vanadium, manganese, and cobalt. Generally, [Mn/Fe] ≃ 0 for the K giants and hence systematically differs from the values found previously for the G-dwarf stars. The correlation between [Na/Fe] and [Fe/H] found for the K giants is different from the one found previously for the G dwarfs. If the sodium abundance determinations are free of systematic error, there is an implication that sodium is presently being synthesized in some K giants. (auth)

**45852** LUMINOSITIES, COLORS, MOTIONS, AND DISTRIBUTION OF FAINT BLUE STARS. Eggen, O. J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena. Australian National Univ., Canberra). Astrophys. J., 16: Suppl. Ser., No. 143, 97-142(Aug. 1968).

Photoelectric (U,B,V) photometry of 500 faint blue stars and 150 possible late-type white dwarfs is used as a sample from which space densities can be estimated. The early-type, DB and DA white dwarfs probably have a space density of an order of magnitude smaller than that of the DF, DG, DK, and DM types. A conservative estimate of the mass density of the white dwarf population near the Sun is $1-2_{\odot}/100\ ps^6$. The blue horizontal branch stars, which may contribute a minimum of 20% to the faint blue star population, can be generally recognized over a limited color range from (U,B,V) photometry, but the bluest HB, WD, and sdOB stars are indistinguishable by this method. (auth)

**45853** RADIO SOURCES OPPOSITE QUASARS AS A COSMOLOGICAL TEST. Piper, D. E. (Cranleigh, Surrey, Eng.). Nature (London), 219: 846-7(Aug. 24, 1968).

Consequences of far reaching cosmological importance have been inferred from the incidence of radio sources in directions nearly opposite to those of known quasars (Solheim, Nature, 219: 45(1968)). Certain intrinsic characteristics appear, however, to have been overlooked associated with the process of sampling a superficial distribution of randomly disposed points. When the data are re-examined, allowing for these effects, they prove to be in much closer accord with what would be expected from a completely random distribution of sources, and suggest that Solheim's conclusions are inadequately substantiated by the evidence. There appears little doubt that the data are other than fully compatible with there being no systematic connection between the antipositions of quasars and known radio sources. This, however, in no way constitutes an argument against a closed Universe model with a pole at redshift $z \sim 1.7$, of the kind proposed by Solheim. (UK)

**45854** PROPER MOTION OF LOCAL QUASISTELLAR OBJECTS AND THE DISTANCES OF 3C273 AND 3C287. Terrell, James (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 21: 637-41(Aug. 26, 1968).

Proper-motion data for 3C 273 are shown to indicate minimum distances of 200,000 to 400,000 lt yr on the basis of origin at the galactic center with relativistic speed. Proper-motion data for 3C 287 give a minimum distance of 200,000 lt yr, and the rapid expansion reported by Matthews indicates a maximum distance of $\sim 2 \times 10^8$ lt yr. Thus these (and other) quasi-stellar objects may have been ejected a few million years ago from the galactic center. (auth)

**45855** OBSERVATIONS OF SAGITTARIUS A AT 1415 AND 2695 MHz. Lequeux, James (Observatoire de Meudon, France). Ann. Astrophys., 31: 349-52(May-June 1968).

Radio studies of the galactic center region are of considerable interest, mostly because there is a strong feeling that it could be the major source of cosmic rays and relativistic electrons. However, this region is very complex and observations at decimeter and meter wavelengths have given somewhat uncertain and fragmentary results, due to the insufficient resolving power of pencil beams or confusion difficulties when using interferometers. The flux and position of the nonthermal center source Sagittarius A are still very poorly known at frequencies under 3000 MHz. New observations made with the large Nancay radiotelescope are presented; its high resolving power allows one to derive better flux densities and right ascensions for this source at 1415 and 2695 MHz. (auth)

**45856** LOCALISED SOLAR ENHANCEMENT AT 1.2 mm. WAVELENGTH. Clark, C. D.; Park, W. M. (Queen Mary Coll., London). Nature (London), 219: 923-4(Aug. 31, 1968).

Detailed measurements are reported of solar radiation in a wavelength range centered at 1.2 mm, showing an especially large amount of solar activity. This activity may indicate a long term increase perhaps associated with increase of the sunspot cycle. Measurements were made with a 1.5-m Cassegrain telescope and using a cooled InSb detector. The solar maps obtained are reproduced. It was clear that the enhancement fluctuated rapidly, often with a period of < 1 min. It is suggested that the observed enhancements were related to two large filaments seen also by direct photography, such filaments being identical with the prominences often observed at the solar limb. The enhancements had brightness temperatures about 100°K above the observed chromospheric brightness temperature of the surrounding disk. Changes of 50°K in the measured apparent temperature occurred over a time scale of 1 min., whilst the features persisted for over an hour without noticeable fall in intensity. Explanations are offered, including a nonthermal mechanism due to spiralling electrons, and possible correlations with type-II radio noise bursts are mentioned. (UK)

**45857** 2000 A HIGH-RESOLUTION PHOTOGRAPHS OF THE SUN. Blamont, J.-E.; Carpentier, G. (CNRS, Verrieres-le-Buisson, France). Ann. Astrophys., 31: 333-43(May-June 1968). (In French).

At 100,000 ft there exists an atmospheric window located between the absorption bands of ozone and molecular oxygen. By using a stratospheric balloon with a 20-cm telescope, photographs of the Sun at 2000 Å were obtained. The telescope was installed aboard a gondola stabilized along 3 axes, the local vertical and two perpendicular axes given by the Sun. The stability of the gondola is better than 1″ for exposure times of $\frac{1}{4}$ sec or less. The f/40 Cassegrain-type telescope with equivalent focal length of 8 meters has an angular resolution of better than 0.5″ under laboratory conditions. The bandwidth given by two interference filters is 125 Å. They are centered at 2000 Å, which is the wavelength of the maximum of transmission at the center of the atmospheric window. The angular field of the instrument is 7′. An Eastman Kodak film 103 aO-UV was used. With a payload of 450 lbs, the balloon attained an altitude of 30.5 km. During 25 min of fine pointing 7 series of 7 photographs were obtained, with exposure times between $\frac{1}{4}$ and $\frac{1}{250}$ sec. The best results were obtained at $\frac{1}{4}$ sec. Photographs taken at $\frac{1}{8}$ sec were underexposed but still usable. Among the photographs with $\frac{1}{4}$-sec exposure the first one has a better angular resolution than the others. It appears to be 1″. (auth)

**45858** SOLAR ACTIVITY. Tandberg-Hansen, Einar. A Blaisdell Book in The Pure and Applied Sciences. Waltham, Mass., Ginn and Company, 1967. 476p.

The different manifestations of solar activity are treated in a unique framework as the inevitable results of the interaction between solar magnetic fields and solar plasma. The purpose of this book—to give a physical understanding of solar activity—is achieved in two steps, utilizing both observational and theoretical treatments. The different models proposed to account for a given set of observations are discussed; then theoretical interpretations and speculations are presented. Written for the advanced student in astrophysics, this text gives a comprehensive account of the "disturbed" conditions that can be found in a "typical" star like the Sun, when magnetic fields upset the "quiet" conditions. (W.D.M.)

**45859** ELECTRICAL HEATING OF METEORITE PARENT BODIES AND PLANETS BY DYNAMO INDUCTION FROM A PRE-MAIN SEQUENCE T TAURI "SOLAR WIND". Sonett, C. P. (Ames Research Center, Moffett Field, Calif.); Colburn, D. S.; Schwartz, K. Nature (London), 219: 924-6 Aug. 31, 1968 .

Preliminary calculations are presented on a heat source for solid objects in the solar system based on a pre-main sequence Sun passing through a T Tauri-like phase. The mechanism is dictinct from the fast heating derived from extinct radionuclides, but has a similar time scale. The model is based on the unipolar dynamo, because of the action of a strongly enhanced solar wind and joule losses in the planetary interior. The motional electric field which drives the unipolar induction current through the planet can be expressed as $E = \omega B_r$, where $\omega$ is the angular spin rate of the Sun, $r$ is the radial distance from Sun to planet, and $B_r$ is the radial component of interplanetary magnetic field. The key parameters in the calculations are the solar spin rate and the temperature $T_0$ of the surface of the investigated body, the surface temperature history appearing to be the most crucial. Other factors included in the calculation are the loss of plasma to the limbs of the body, and the requirement that the power loss in the body never exceeds the available power in the solar wind. The T Tauri flow assumed for the problem is discussed. (UK)

**45860** SOLAR CORONA AT CENTIMETRE WAVELENGTHS. Kaufmann, P.; Matsuura, O. T. (Mackenzie Univ., Sao Paulo, Brazil). Nature (London), 219: 921-2(Aug. 31, 1968).

Detailed solar spectral information in the wavelength range 3 to 21 cm was obtained at four observing sites on November 12, 1966, during total solar eclipse measurements. The data are used to discuss the cm wavelength solar corona. The spectrum remained nearly flat in the microwave frequency range, a result compatible with the radio emission from a volume of thermal plasma observed through a solid angle nearly constant in the frequency range considered. The brightness temperature $T_b$ of the whole corona was estimated from the flux values, and is shown plotted, the curve obtained corresponding well to a relationship for the radio emission of an optically thin thermal plasma. From observations at 7 GHz it was possible to estimate the brightness temperature of coronal regions near the solar equator as $T_b \simeq 27 \times 10^3$ °K, and an equatorial brightness temperature of $\sim 24 \times 10^3$ °K. It was also indicated that the equatorial corona must be much brighter than the polar regions, and that the equivalent brightness temperature for the polar sectors is of the order of $2 \times 10^3$ °K. Information was also inferred on the ellipticity of the cm-wavelength corona. (UK)

**45861** ASTRONOMICAL IMPLICATIONS OF A COSMOLOGICAL THEORY OF LIGHT PROPAGATION. Prokhovnik, S. J. (Univ. of New South Wales, Kensington). Int. J. Theor. Phys., 1: 101-5(May 1968).

It is shown that a simple cosmological model of light propagation permits the existence and observation of recession velocities greater than c, though the Einstein measure of these velocities remains less than c in accordance with relativistic theory. The recent observation of quasars with red-shifts greater than unity is interpreted in terms of an exponential Doppler Law which is a consequence of the model. This law is further employed to provide an improved quantitative interpretation of the observed density of strong radio sources. (auth) (UK)

**45862** WHITE DWARFS. Weidemann, Volker (Univ., Kiel). Annu. Rev. Astron. Astrophys., 6: 351-72(1968).

This review is restricted to facts and theoretical aspects which are important for a straightforward interpretation of the observational material available, and emphasis is on methods involving spectroscopic and photometric results. Topics covered include basic information, atmospheres, temperature scale, effective temperature and surface gravity of 40 Eri B, bolometric corrections, masses (Einstein shift), white-dwarf evolution (cooling law), luminosity function, space density, and pre-white dwarf evolution. 94 references. (W.D.M.)

**45863** WOLF–RAYET STARS. Underhill, Anne B. (Sonnenborgh Observatory, Utrecht). Annu. Rev. Astron. Astrophys., 6: 39-78(1968).

Properties of the Wolf–Rayet stars of the first group (OB stars of Population I) are reviewed in terms of spectral classification systems, number and distribution of W–R stars, variability, masses, typical dimensions, absolute magnitudes, continuous spectrum, meaning of the line spectrum, theories of W–R spectra, and evolutionary stage. (W.D.M.)

**45864** MEASUREMENT OF STELLAR DIAMETERS. Brown, R. Hanbury (Univ. of Sydney). Annu. Rev. Astron. Astrophys., 6: 13-38(1968).

Measurement of the apparent angular diameters of single stars by means of an interferometer and also by observing occultations by the Moon is discussed. Observations of double stars and eclipsing spectroscopic binaries are not considered. By measuring the angular diameter of stars of different spectral type it is possible to establish a scale of effective temperatures. (W.D.M.)

**45865** VARIABLE RADIO SOURCES. Kellermann, K. I.; Pauliny-Toth, I. I. K. (National Radio Astronomy Observatory, Green Bank, W. Va.). Annu. Rev. Astron. Astrophys., 6: 417-48(1968).

The radio and, to a lesser extent, the optical variations from extragalactic radio sources (radiogalaxies and quasars) are considered. The radio variations in galactic supernova remnants and the optical variations in the apparently radio-quiet quasi-stellar galaxies and Seyfert galaxies are included to the extent that they may give some insight into the phenomena involved in the radio galaxies and quasars. 137 references. (W.D.M.)

**45866** OBSERVATIONAL TECHNIQUES IN X-RAY ASTRONOMY. Giacconi, R.; Gursky, H.; Van Speybroeck, L. P. (American Science and Engineering, Cambridge, Mass.). Annu. Rev. Astron. Astrophys., 6: 373-416(1968).

Various techniques that have evolved for use in x-ray astronomy are reviewed. An attempt is made to present the general requirements for performing successful experiments without necessarily presenting detailed analysis of particular instruments, and to discuss the particular quantities that are apparently important and the intrinsic limitations that are imposed by nature, both in the instruments and in the phenomena. 96 references. (W.D.M.)

**45867** RADIO SPECTRA. Scheuer, P. A. G.; Williams, P. J. S. (Cambridge Univ., Eng.). Annu. Rev. Astron. Astrophys., 6: 321-50(1968).

This article is concerned with the radio spectra of sources such as supernova remnants, radio galaxies, and quasars, whose radio emission is generally attributed to synchrotron radiation; these are continuous spectra. Radiation from relatively dense ionized gaseous nebulae or the 1420-MHz line emission from H I are not considered. 109 references. (W.D.M.)

**45868** COUNTS OF RADIO SOURCES. Ryle, M. (Cambridge Univ., Eng.). Annu. Rev. Astron. Astrophys., 6: 249-66(1968).

A description is given of the extension of the radio source count observations to a limiting flux density $S_{178} = 2 \times 10^{-26}$ W m$^{-2}$ Hz$^{-1}$ in the 4C survey and subsequently to a value of $S_{178} = 0.25 \times 10^{-26}$ W m$^{-2}$ Hz$^{-1}$ over a small area near the North Pole. The completion of the one-mile telescope at Cambridge has allowed an important development in this work. The observations now extend to sources having a limiting flux density $S_{408} = 0.01 \times 10^{-26}$ W m$^2$ Hz$^{-1}$; the results obtained are given and the most complete information that is now available on the source counts is presented. The interpretation of these results is considered and the nature of the quasars is discussed. 69 references. (W.D.M.)

**45869** PHYSICS OF COMET TAILS. Brandt, John C. (Goddard Space Flight Center, Greenbelt, Md.). Annu. Rev. Astron. Astrophys., 6: 267-86(1968).

The gross structure and orientation of Type-I and Type-II comet tails are reviewed. 91 references. (W.D.M.)

**45870** STRUCTURE OF SUNSPOTS. Zwaan, Cornelis (Sacramento Peak Observatory, Sunspot, N. Mex.). Annu. Rev. Astron. Astrophys., 6: 135-64(1968).

This review focuses on sunspots as individual and almost stationary structures. Most attention is paid to the observations of features in the photospheric layers and their direct interpretation. Sections of a previous paper (Zwaan 1965) are referenced several times. 111 references. (W.D.M.)

**45871** STATISTICS OF SOLAR ACTIVE REGIONS. Sawyer, Constance (Environmental Science Services Administration Research Labs., Boulder, Colo.). Annu. Rev. Astron. Astrophys., 6: 115-34(1968).

Direct evidence indicates that an active region on the Sun is part of an organization that can be recognized over months and years. In places that are far removed from the source of new activity — in the interplanetary fields near the Earth or at high latitudes on the Sun — the pattern is most stable and most easily seen. In active latitudes, the continual appearance of new activity gives an impression of ever-changing patterns but statistical studies show that here, too, an underlying structure persists, and frequent renewal of concentrated magnetic fields leads to the complexity and rapid change associated with the most energetic flare events. 66 references. (auth)

**45872** OBSERVED PROPERTIES OF THE INTERPLANETARY PLASMA. Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). Annu. Rev. Astron. Astrophys., 6: 79-114 (1968).

This paper is concerned with a review of the present state of observational knowledge of the interplanetary medium which will indicate the complex properties which exist and their relationship to the Sun and Earth. Attention is given only to the magnetized and ionized gas in interplanetary space, not to the neutral gas or particulate matter known to be present. (W.D.M.)

**45873** STRUCTURE AND DYNAMICS OF THE INTERSTELLAR MEDIUM. Pikel'ner, S. B. (Sternberg Astronomical Inst., Moscow). Annu. Rev. Astron. Astrophys., 6: 165-94(1968).

Structure and dynamics of interstellar space are reviewed under the topics of rotation and systematic deviations, disk thickness, spiral arms, barred spirals, interstellar clouds, cloud temperature, cloud formation, expansion of H II regions and cloud motion, expansion of supernova shells, general dynamics of the interstellar gas, and magnetic-field structure. 108 references. (W.D.M.)

**45874** *NONSTATIC SOLUTIONS WITH SPHERICAL SYMMETRY FOR JORDAN–THIRY FIELD EQUATIONS.* Dangvu, Huyen (Institut Henri Poincare, Paris). Compt. Rend., Ser. A and B, 267: 61-4(July 1, 1968). (In French).

The static solutions with spherical symmetry for the Jordan–Thiry field equations were studied previously. Several nonstatic solutions are calculated. Then a cosmology is formulated according to the Jordan–Thiry theory. (tr-auth)

**45875** EQUATION OF STATE AT SUPRANUCLEAR DENSITIES AND THE EXISTENCE OF A THIRD FAMILY OF SUPERDENSE STARS. Gerlach, Ulrich H. (Princeton Univ., N. J.). Phys. Rev., 172: 1325-30(Aug. 25, 1968).

A method is presented for deducing the equation of state of "cold" matter at supranuclear densities from astronomical data. In particular, from the masses and the radii of a sequence of superdense stars composed of degenerate matter, one can determine the equation of state. The relationship between the equation of state and the mass-radius curve is used to construct an equation of state that allows a third family of superdense stars. (auth)

**45876** INTERGALACTIC MATTER. Gould, Robert J. (Univ. of California, San Diego, La Jolla). Annu. Rev. Astron. Astrophys., 6: 195-214(1968).

For many years consideration has been given to the possibility of a low-density gas filling intergalactic space. The subject of this review is not only this gaseous component, but also the photon spectrum and the "suprathermal" (cosmic-ray) component of intergalactic matter. The possibility of observing the large-scale properties of the universe has become evident during the past few years with the discovery of the quasars, the observation of cosmic black-body radiation, and the developments in x-ray astronomy. 52 references. (W.D.M.)

**45877** INTERSTELLAR DUST. Lynds, Beverly T. (Univ. of Arizona, Tucson); Wickramasinghe, N. C. Annu. Rev. Astron. Astrophys., 6: 215-48(1968).

The overall picture which is presently emerging is that the solid particles of the interstellar medium tend to exist in discrete clouds, perhaps occasionally in circumstellar clouds. The intercloud space appears to be quite transparent. The particles themselves are very likely composite, with a highly refractory core such as graphite and a more volatile icy outer mantle. The cores themselves probably have quite a different point of origin from the mantles of the particles, and the inclusion of "impurities" within both the cores and the mantles may grossly affect the energy balance between the grains and the radiation field in which they exist. It is apparent that within each of the sections covered by this review, further laboratory, observational, and theoretical work needs to be done before any final answer on the precise nature and properties of the interstellar dust can be established. 90 references. (auth)

**45878** TWISTOR QUANTISATION AND CURVED SPACE–TIME. Penrose, Roger (London Univ.). Int. J. Theor. Phys., 1: 61-99(May 1968).

The formalism of twistors [the "spinors" for the group O(2,4)] is employed to give a concise expression for the solution of the zero rest-mass field equations, for each spin ($s = 0, \frac{1}{2}, 1, \ldots$), in terms of an arbitrary complex analytic function $f(Z^\alpha)$ (homogeneous of degree $-2s-2$). The four complex variables $Z^\alpha$ are the components of a twistor. In terms of twistor space (C-picture) it is analytic structure which takes the place of field equations in ordinary Minkowski space-time (M-picture). By requiring that the singularities of $f(Z^\alpha)$ form a disconnected pair of regions in the upper half of twistor space, fields of positive frequency are generated. The twistor formalism is adapted so as to be applicable in curved space-times. The effect of conformal curvature in the M-picture is studied by consideration of plane (-fronted) gravitational "sandwich" waves. The C-picture still exists, but its complex structure "shifts" as it is "viewed" from different regions of the space-time. A weaker symplectic structure remains. The shifting of complex structure is naturally described in terms of Hamiltonian equations and Poisson brackets, in the twistor variables $Z^\alpha$, $\overline{Z}_\alpha$. This suggests the correspondence $\overline{Z}_\alpha = \partial/\partial Z^\alpha$ as a basis for quantization. The correspondence is then shown to be, in fact, valid for the Hilbert space of functions $f(Z^\alpha)$, which give the above twistor description of zero rest-mass fields. For this purpose, the Hilbert space scalar product is described in (conformally invariant) twistor terms. The twistor expressions for the charge and the mass, momentum, and angular momentum (both in "inertial" and "active" versions, in linearized theory) are also given. It is suggested that twistors may supply a link between quantum theory and space–time curvature. On this view, curvature arises whenever a "shift" occurs in the interpretation of the twistor variables $Z^\alpha$, $\overline{Z}_\alpha$ as the twistor "position" and "momentum" operators, respectively. (auth)

**45879** *"PHOTON STORMS" IN THE HOT UNIVERSE.* Ozernoi, L. M.; Chernin, A. D. (Lebedev Inst. of Physics, Moscow. Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 7: 342-5(June 5, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 436-9(June 5, 1968).

The serious difficulties of the fluctuation theory of galaxy formation in the Friedmann cosmological model has made it necessary to return to a discussion of the old idea of the existence, even at a relatively early stage of the evolution of the metagalaxy, of some pregalactic structure variations greatly exceeding in amplitude the statistical fluctuations of the density. Previously the authors (1968) formulated an alternative hypothesis of dynamic structure, according to which vortical motions of the photon gas and the plasma dragged by it (photon storms) existed in the Universe during the epoch when the radiation energy density exceeded the energy density of the matter. The photon storm hypothesis is discussed. (W.D.M.)

**45880** 3-SPHERE "BACKGROUNDS" FOR THE SPACE SECTIONS OF THE TAUB COSMOLOGICAL SOLUTION. Matzner, Richard A. (Cambridge Univ., Eng. Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 9: 1063-7(July 1968).

The cosmological solution due to Taub resembles a radiation-filled Robertson–Walker solution which contains long-wavelength gravitational radiation rather than electromagnetic radiation. This paper presents several schemes for obtaining 3-sphere "backgrounds" for the t = const space slices M(t) in the Taub solution. [M(t) is characterized by being homogeneous for each t.] The reason for finding such backgrounds is to present models for defining wave-background separation in general. Unspecified averaging methods as suggested by Isaacson work for short-wavelength gravitational radiation. We attempt here to specify a method which works even when the radiation is of long wavelength. One background is obtained by averaging the metric by Lie transport along certain invariantly defined vector fields on M(t). This background is compared with two other (different) plausible definitions for a background, and reasons are given to suggest that the Lie-transport average is the preferable definition. (auth)

**45881** MODELS FOR SCATTERING IN A SPHERICAL NEBULA. Kurchakov, A. V.; Matyagin, V. S. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 169-70 (July-Aug. 1968).

Translated from Astron. Zh., 45: 211-13(Jan.-Feb. 1968).

A new approach is developed to the solution of the problem of light scattering in a nebula. Utilizing a digital computer, it involves a statistical analysis of the random walk of photons (a version of the Monte Carlo method). (auth)

**45882** STATISTICS OF OPEN CLUSTERS. Fesenko, B. I. (Pskov Teachers' Coll., USSR). Sov. Astron. AJ (Engl. Transl.), 12: 167-8(July-Aug. 1968).

Translated from Astron. Zh., 45: 210-11(Jan.-Feb. 1968).

Evidence is presented that the classes of neighboring open clusters are mutually independent. (auth)

**45883** STRUCTURE OF THE HYADES. Nalimov, V. N. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 144-9(July-Aug. 1968).

Translated from Astron. Zh., 45: 181-8(Jan.-Feb. 1968).

The structure of the Hyades is elucidated and compared with the structure and dimensions of other nearby open clusters. Distribution curves are obtained for the apparent density, as well as the space density of the member stars, as computed by Kholopov's method and a method developed by the author. The radius of the Hyades is found to be 10°; the radius of the cluster nucleus, 4°. The space density distribution curves derived by the author's method fall systematically below the curves derived by Kholopov's method; the disparity amounts to 20%. (auth)

**45884** EXPLOSIONS OF LARGE STARS. Bisnovatyi-Kogan, G. S. Sov. Astron. AJ (Engl. Transl.), 12: 58-62(July-Aug. 1968).

Translated from Astron. Zh., 45: 74-80(Jan.-Feb. 1968).

A discussion is given of the dynamics of contraction and nuclear explosion of a large star ($M < 6 \times 10^4\ M_\odot$) after the loss of stability due to general-relativity effects. The initial chemical composition is taken to be 70% hydrogen by weight, 30% helium, and heavy elements absent. This composition corresponds to the primordial material in a hot universe following expansion and the cessation of nuclear reactions, if any entropy corresponding to the present temperature of the primordial radiation, 3°K, and to estimates for the present density, is adopted. A calculation shows that for stars with $M < 6 \times 10^4\ M_\odot$ intensive nuclear reactions capable of supporting the radiation will take place in an equilibrium stage; the star will collapse after its nuclear fuel is exhausted. For stars with $6 \times 10^4\ M_\odot < M < 1.5 \times 10^5\ M_\odot$ a nuclear detonation during the collapse process will lead to dispersal of the whole star, while for $M > 1.5 \times 10^5\ M_\odot$ the energy of explosion will be inadequate for dispersal of the whole star. The problem is solved for

the case of homologous contraction. Although such a treatment does not enable the possible appearance of shock waves or the ejection of part of the mass to be taken into account, the problem does reduce to the solution of a system of ordinary differential equations. The chemical composition of the dispersing material is determined. The energy released in the explosion is practically equal to the energy released through hydrogen burning. (auth)

**45885** SIMILARITY THEORY FOR STELLAR MODELS. Imshennik, V. S.; Nadezhin, D. K. Sov. Astron. AJ (Engl. Transl.), 12: 63-6(July-Aug. 1968).

Translated from Astron. Zh., 45: 81-5(Jan.-Feb. 1968).

Similarity criteria are formulated for stellar models with allowance for radiation pressure and the presence of a convective core. The dependence of the model characteristics on the parameter $\mu^2 M_\odot$ is calculated for various values of the exponents in the opacity and energy-radiation formulas. (auth)

**45886** CONVECTIVE ENVELOPES OF STARS IN THE GRAVITATIONAL-CONTRACTION STAGE. Zhilyaev, B. E.; Kolesnik, I. G. (Central Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.), 12: 67-73(July-Aug. 1968).

Translated from Astron. Zh., 45: 86-94(Jan.-Feb. 1968).

Convective model envelopes were calculated for three T Tauri variables: T Tau, GW Ori, and Lk H$\alpha$ 120. Contracting stars have a larger spatial turbulence scale than main-sequence stars. For pre-main-sequence stars the internal energy of the convection elements is 4 to 5 orders higher than for the Sun. The emergence of these elements in the outer atmospheric layers of a contracting star might explain the flares that are observed. As a contracting star approaches the main sequence, the eruptive activity of its convection zones should diminish. (auth)

**45887** ESTIMATE FOR THE MIXING LENGTH FROM STELLAR-VARIABILITY THEORY. II. Aleshin, V. I. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 12: 74-9 (July-Aug. 1968).

Translated from Astron. Zh., 45: 95-102(Jan.-Feb. 1968).

The theory of stellar variability yields an estimate for an upper bound on the mixing length. Convective energy transfer diminishes the amount of negative dissipation of the pulsational energy developed by the He II zone; if the convective energy transfer is sufficiently strong the self-excitation of pulsations will become impossible. Moreover, an enhanced role of convective transfer will change the lag in the phase of maximum light of the star relative to the phase of maximum contraction for RR Lyr and $\delta$ Cep variable-star models into a phase lead. These circumstances imply that the ratio of the mixing length to the scale height in the atmospheres of pulsating stars cannot exceed 3. (auth)

**45888** ATMOSPHERES OF BETA CANIS MAJORIS STARS. I. GAMMA PEGASI. Orlov, M. Ya. (Central Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.), 12: 89-94(July-Aug. 1968).

Translated from Astron. Zh., 45: 115-20(Jan.-Feb. 1968).

Equivalent widths and central depths were measured for the hydrogen and helium lines of spectrograms of $\gamma$ Peg (dispersion 14 Å/mm) covering the entire period of radial-velocity variation. Any variations in these quantities fall within the range of accuracy of the determinations. The electron density in the stellar atmosphere is determined from the number of the last observable Balmer line and from two variants of Unsöold's method. (auth)

**45889** A QUANTITATIVE SPECTRUM ANALYSIS OF NOVA HERCULIS 1963. II. DETERMINATION OF THE PHYSICAL PARAMETERS OF THE STAR AND THE ENVELOPE IN ITS NEBULAR STAGE. Doroshenko, V. T. Sov. Astron. AJ (Engl. Transl.), 12: 95-104(July-Aug. 1968).

Translated from Astron. Zh., 45: 121-32(Jan.-Feb. 1968).

The results are discussed of an analysis of spectra of Nova Herculis 1963 covering the wavelength range 3100 to 6600 Å, obtained in April–November 1963, with a quartz spectrograph mounted on the 125-cm reflector of the Shternberg Astronomical Institute's Southern Station. The temperature of the star and the electron density and electron temperature of the envelope were determined as functions of time. The chemical composition of the envelope was ascertained. The envelope contributes 30% of the continuum radiation in the vicinity of the H$\beta$ line. (auth)

**45890** STELLAR ENERGY DISTRIBUTION AT INFRARED WAVELENGTHS. Komarov, N. S.; Pozigun, V. A. (Odessa Astronomical Observatory). Sov. Astron. AJ (Engl. Transl.), 12: 105-9(July-Aug. 1968).

Translated from Astron. Zh., 45: 133-8(Jan.-Feb. 1968).

A description is given of a photoelectric spectrophotometer for observations in the near infrared region. The energy distributions in the continua of $\alpha$ Lyr, $\alpha$ Cyg, $\beta$ Ari, $\alpha$ Tau, and $\alpha$ Ori are compared with the data given by Code and Jones. The energy distributions of $\beta$ And, $\alpha$ Ari, and $\alpha$ Cet over the range 6000 to 10,000 Å are determined. (auth)

**45891** PERIODIC BRIGHTNESS VARIATIONS OF AG PEG. Belyakina, T. S. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 110-11(July-Aug. 1968).

Translated from Astron. Zh., 45: 139-40(Jan.-Feb. 1968).

Photoelectric observations revealed that from 1962 to 1966 the brightness of Ag Peg varied with a period of close to 800 days and with an amplitude of $0.3^m$ in yellow light. (auth)

**45892** SPECTRA OF THE COMPONENTS OF THE GALACTIC RADIO SOURCE 3C 398 (W 49). Dagkesamanskii, R. D.; Kostenko, V. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 122-4(July-Aug. 1968).

Translated from Astron. Zh., 45: 154-6(Jan.-Feb. 1968).

The results are reported of observations of the region around the radio source 3C 398 (W 49) at frequencies of 38, 86, and 5760 MHz. The observational data thus far accumulated can satisfactorily be represented by two components differing in the character of their spectra: a thermal component with an emission measure $EM \approx 3 \times 10^5$ cm$^{-6}$ pC and an electron temperature $T_e \approx 3 \times 10^{3}$°K, and a nonthermal component with a spectral index $\alpha = 0.43$ over the 86 to 5760 MHz range. The low-frequency deficiency found in the spectrum of the nonthermal component may be caused by absorption in H II zones located along the line of sight. (auth)

**45893** TOTAL ENERGY OF RELATIVISTIC PARTICLES AND MAGNETIC FIELD IN DISCRETE RADIO SOURCES EXHIBITING REABSORPTION. Braude, S. Ya.; Vaisberg, V. V. (Inst. of Radiophysics and Electronics, Kiev). Sov. Astron. AJ (Engl. Transl.), 12: 125-7(July-Aug. 1968).

Translated from Astron. Zh., 45: 157-9(Jan.-Feb. 1968).

The ratio of the total energy of relativistic electrons and magnetic field to the minimum energy was calculated for sources exhibiting reabsorption. The calculation was performed for two radio galaxies and one quasar. (auth)

**45894** RADIO-BRIGHTNESS DISTRIBUTION OF THE CRAB NEBULA AT 535 MHz. Matveenko, L. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 128-32 (July-Aug. 1968).

Translated from Astron. Zh., 45: 160-5(Jan.-Feb. 1968).

From lunar-occultation curves for the Crab Nebula at 535 MHz, radio isophotes were derived for the nebula, and the position of its center of gravity was determined. The radio-brightness distribution agrees with the optical distribution, but the peripheral regions and local formations exhibit greater contrast. The radio flux density of source No. 1 corresponds to a spectral index of $-1.2$. (auth)

**45895** ACCELERATION OF CHARGED PARTICLES BY THE DISSIPATIVE FORCE IN A RADIATION FLUX. Gurevich, L. E.; Rumyantsev, A. A. Sov. Astron. AJ (Engl. Transl.), 12: 133-4(July-Aug. 1968).

Translated from Astron. Zh., 45: 166-8(Jan.-Feb. 1968).

The force acting on charged particles in a radiation flux is examined. This force results from the fact that collisions "knock out" the oscillation phase of particles in the wave field. It is shown that this "dissipative" force on radio frequencies can exceed the force, examined earlier by the authors, caused by the Thomson scattering of radiation and its absorption in the case of free–free transitions. This force can be substantial in the case of particle acceleration in cosmic sources of radio emission. (auth)

**45896** POLARIZATION OF TYPE-II AND TYPE-III SOLAR RADIO BURSTS. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 21-7(July-Aug. 1968).

Translated from Astron. Zh., 45: 28-35(Jan.-Feb. 1968).

The effect of conditions for the escape and propagation of radio emission on the polarization of type-II and type-III bursts is examined. It is shown that when the nature of the agents responsible for the burst is taken into account these conditions can explain the polarization for type-II bursts. The dependence of the degree of polarization of type-III bursts on time at a fixed frequency is analyzed. Polarization in the second harmonic of type-III bursts is examined, taking into account that the radio emission reaches the Earth after reflection from corresponding coronal layers. (auth)

**45897** QUASIPERIODIC SOLUTIONS OF THE FIRST KIND IN THE PLANE n-BODY PROBLEM. Krasinskii, G. A. (Inst. of Theoretical Astronomy, Leningrad). Sov. Astron. AJ (Engl. Transl.), 12: 155-61(July-Aug. 1968).

Translated from Astron. Zh., 45: 195-204(Jan.-Feb. 1968).

The plane problem of the motion of n bodies of small mass

relative to a central body is considered. For definite relations between the perturbing masses, n-fold quasiperiodic solutions are shown to exist; they degenerate into circular motions with incommensurable periods in the case where the perturbations vanish. (auth)

**45898** ORIGIN OF TYPE-V SOLAR RADIO BURSTS. Zheleznyakov, V. A.; Zaitsev, V. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 12: 14-20(July-Aug. 1968).

Translated from Astron. Zh., 45: 19-27(Jan.-Feb. 1968).

It is demonstrated that type-V bursts are generated primarily at twice the electron plasma frequency. The phenomenon is related to the capture of some of the fast electrons responsible for type-III bursts in a magnetic trap (a region where the magnetic field is bipolar) and to multiple reflection of the captured particles from magnetic mirror points. As a result of these processes there forms in the trap a system of two opposing beams, which generate plasma waves with wave vectors in opposite directions. These waves are effectively converted to electromagnetic radiation when each scatters the other. The radiation thus generated for frequency $\omega \simeq 2\omega_L$ makes it possible to explain all of the basic features of type-V bursts, including the high intensity and the lack of appreciable polarization and directivity, as well as the occurrence of type-V bursts as "detached" bursts. The electron concentration in the opposing beams at the observed intensity is of the order of $5 \times 10^2$ electrons/cm$^3$. (auth)

**45899** SIZES OF LOCAL SOURCES OF SOLAR RADIO EMISSION AT A WAVELENGTH OF 4.5 cm. Korzhavin, A. N.; Peterova, N. G. (Main Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 28-35(July-Aug. 1968).

Translated from Astron. Zh., 45: 36-44(Jan.-Feb. 1968).

The results are given of a statistical treatment of the sizes of local sources of radio emission associated with sunspot groups of small area. The investigation was based on observations of the Sun at a wavelength of 4.5 cm with a resolution of about two minutes of arc made with the large Pulkovo radio telescope during 1962 to 1965. It was found that local sources associated with unipolar sunspot groups are 1.5 times larger than local sources associated with bipolar sunspot groups. For bipolar sunspot groups the local sources have dimensions of the same order as the sizes of the groups in the photosphere: in the unipolar case the local sources are 4 to 6 times larger than the associated groups. The correlation coefficient of the sizes of the local sources with the areas of the sunspot groups and also with the intensity of the magnetic field in the spots was found to lie between the limits 0.5 and 0.7. The dependence of the sizes of the local sources on their distance from the center of the disk of the Sun is close to but a little weaker than a cosine law for the unipolar groups: in the case of bipolar groups practically no dependence at all was found. (auth)

**45900** COMPARATIVE STUDY OF THE BEHAVIOR OF LINES ON THE SOLAR DISK FROM ECLIPSE AND OUT-OF-ECLIPSE OBSERVATIONS. Murasheva, M. S.; Kozhevnikov, N. I.; Sitnik, G. F. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 36-9(July-Aug. 1968).

Translated from Astron. Zh., 45: 45-9(Jan.-Feb. 1968).

Photoelectric measurements of the solar spectral region λ 4281 to 4302 Å were made during the annular eclipse of May 20, 1966 and out of eclipse. Analysis of these measurements indicates that, within the measurement error, scattered light exerts no disturbing influence on the profiles of lines observed at different distances from the center of the solar disk. It can apparently be assumed that out-of-eclipse observations of variations in the profiles of lines on the solar disk to a distance of 0.97 $R_\odot$ from the center give valid results, with distortion by scattered light not exceeding the measurement error. The data obtained indicate that the wings of the subordinate lines are weaker at the solar limb but that the lines become wider at the limb than in the center. The rotational lines of CH molecules, at the center of the disk, are deeper at the line centers and narrower than they are at the limb. (auth)

**45901** LYMAN-α RADIATION FIELD IN A CHROMOSPHERIC FILAMENT. Yakovkin, N. A.; Zel'dina, M. Yu. (Kiev State Univ. Observatory). Sov. Astron. AJ (Engl. Transl.), 12: 40-8 (July-Aug. 1968).

Translated from Astron. Zh., 45: 50-61(Jan.-Feb. 1968).

The integral equation for the diffusion of chromospheric Lyman-α radiation in a plane-parallel layer of optical thickness $10^5$ is solved. The Voight absorption coefficient and a true frequency redistribution of energy in an elementary scattering event are adopted. The mean relative population of the second quantum level of the hydrogen atom is found to be $1.0 \times 10^{-7}$. There is a buildup of phonons near the chromosphere; the photon concentration is 1.5 times as great as in the absence of a filament. The line profile for Ly-α radiation diffusely reflected in the direction toward the Sun is well described by the complete-redistribution approximation only near the core of the line. In the wings ($\Delta\lambda > 4\Delta\lambda_D$) scattering occurs without change of frequency; the corresponding source functions depend linearly on optical depth. The filament surface brightness in the Ly-α line comprises 30% of the chromosphere brightness independently of its position on the solar disk. (auth)

**45902** DISPLACEMENT AND BROADENING OF FRAUNHOFER LINES. II. VARIATION OF TURBULENT VELOCITY IN THE SOLAR ATMOSPHERE. Aslanov, I. A.; Davudov, Yu. D.; Salmanov, I. R. (Shemakha Astrophysical Observatory, Baku). Sov. Astron. AJ (Engl. Transl.), 12: 49-53(July-Aug. 1968).

Translated from Astron. Zh., 45: 62-8(Jan.-Feb. 1968).

The turbulence in the solar atmosphere and the height dependence of the microturbulence velocity were studied by the curve-of-growth method. For this purpose all the Fe I lines in the region of the solar spectrum considered were subdivided into groups with optical depths in the intervals 0.000 to 0.010, 0.010 to 0.020, and so on. An overall curve of growth and a curve for each group separately were then constructed, and the microturbulence velocity determined for each group. As the mean optical depth increased from 0.007 to 0.073, the microturbulence velocity declined from 1.24 to 0.90 km/sec. The microturbulence velocity was also determined for the solar atmosphere; its value was 0.56 km/sec. (auth)

**45903** EFFECT OF TERM PARITY ON THE CURVE OF GROWTH. Kuli-Zade, D. M. (Shemakha Astrophysical Observatory, Baku). Sov. Astron. AJ (Engl. Transl.), 12: 54-7 (July-Aug. 1968).

Translated from Astron. Zh., 45: 69-73(Jan.-Feb. 1968).

A curve of growth plotted for the center of the solar disk from 228 Fe I lines exhibits a sharp distinction between the points corresponding to even–odd and odd–even transitions. Lines with odd lower terms fall systematically higher on the curve of growth than lines with even lower terms. The velocity of microturbulent motion, the damping constant, and the excitation temperature determined from the lines of odd–even transitions are considerably greater than the values determined from even–odd transitions. It is suggested that the difference found in the curves of growth, and thereby in the physical properties of the solar photosphere, results from a differential effect of pressure on even and odd terms. (auth)

**45904** COMPARISON OF DESCRIPTIONS OF GALAXIES IN THE MORPHOLOGICAL CATALOG OF GALAXIES WITH THEIR CLASSIFICATIONS. Vorontsov-Vel'yaminov, B. A.; Noskova, R. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 112-15(July-Aug. 1968).

Translated from Astron. Zh., 45: 141-5(Jan.-Feb. 1968).

The descriptions of galaxies in the Morphological Catalog of Galaxies (MCG) are compared with de Vaucouleurs' and Hubble's classification systems. Of the galaxies described in the MCG as E objects, N or N; H objects, and (N) or (N); H objects, de Vaucouleurs classifies 95, 90, and 55% respectively as E or S0 objects. Most of the galaxies seen edgewise and described in the MCG as L or L; H also belong to type S0. Of the galaxies classified by de Vaucouleurs as SAB and SB, only 20 and 46% respectively are noted in the MCG as possessing a bar. Among the SAB and SB galaxies, spiral arms are not recorded in the MCG for 13 and 20% respectively, nor for 15% of the SA galaxies. Edgewise and overexposed systems predominate among these in the MCG. Since the structural character of each feature in a galaxy is recorded individually in the MCG, no opportunity is afforded for a comparison with subtypes such as Sa, Sb, or SBa. About 70% of the galaxies described in the MCG as Fa are classified by de Vaucouleurs as S0–Sa. De Vaucouleurs regards almost all the objects described as Fb as spirals; he classifies about 70% of them as later than Sa. According to de Vaucouleurs nearly all the Fcd–Fi are late-type spirals, while those described as F are either S0, Sc, or irregular. (auth)

**45905** A SUBSYSTEM OF BRIGHT GLOBULAR CLUSTERS IN THE ANDROMEDA NEBULA. Sharov, A. S. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 116-21(July-Aug. 1968).

Translated from Astron. Zh., 45: 146-53(Jan.-Feb. 1968).

The high-luminosity globular clusters in the Andromeda Nebula form an ellipsoidal subsystem with a major semiaxis of about 76.5′ and an axial ratio $\eta = 0.660$. The space density of the clusters at the center of the Nebula is approximately 500 to 700 times the density at the boundary of the subsystem. The gradients in the space density of the clusters along the R coordinate in the Milky Way and in the Andromeda Nebula practically coincide. (auth)

**45906** REST MASS OF A PHOTON. Marochnik, L. S. (Inst. of Astrophysics, Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 171-2(July-Aug. 1968).

Translated from Astron. Zh., 45: 213-15(Jan.-Feb. 1968).

It is shown that if Einstein's cosmological constant Λ is different from zero, a photon would have a nonvanishing rest mass $m_0$ related to Λ. (auth)

**45907** EQUILIBRIUM STATE OF A ROTATING MAGNETIC GAS SPHERE. Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.), 12: 80-8 (July-Aug. 1968).

Translated from Astron. Zh., 45: 103-14(Jan.-Feb. 1968).

An analysis was made of the equilibrium of a gas sphere symmetric about its rotation axis but with an arbitrary distribution of angular velocity and magnetic field. The ratio of the centrifugal or electromagnetic force to the gravitational force was assumed to be small. Problems associated with the meridional circulation of material are discussed, and formulas are derived for the entropy and energy of the sphere. The entropy of the sphere will in general be some function of the disturbing force. If interactions with the ambient medium cause a rapid loss of angular momentum, the change in entropy may exert some influence on the heat-balance condition. With a polytropic model of index n = 1 as an illustration, it is shown that configurations may exist whose radius, even for a small disturbing force, differs considerably from the radius of an undisturbed sphere. (auth)

**45908** DETERMINATION OF ASPECT AND DEGREE OF DIFFERENTIAL ROTATION FROM LINE PROFILES IN RAPIDLY ROTATING STARS. Stoeckley, Thomas R. (Cambridge Observatories, Eng.). Mon. Notic. Roy. Astron. Soc., 140: 121-39 (1968).

The study described is an attempt to demonstrate that the angles of inclination of the rotational axes, as well as the presence or absence of differential rotation, can be determined from accurate measurements of absorption line profiles in the spectra of rapidly rotating stars, using second-order effects in these profiles caused by departures of the figures of such stars from spherical symmetry. An important tool is the fact that the second-order effects differ for different absorption lines. Computations of rotationally broadened profiles of He I 4471, Mg II 4481, and Ca II 3934 are presented and compared with measurements in five bright rapidly rotating B- and A-type main-sequence stars. Preliminary conclusions are that the surface rotation law appears to be either solid-body (uniform), or differential (nonuniform) with angular velocity increasing toward the poles. The aspects (orientations) of two Be stars, determined from measured line profiles, are consistent with the hypothesis that these stars are rotating near the equatorial breakup velocity. (auth) (UK)

**45909** ABSORPTION LINE STRENGTHS IN ROTATING STARS. Stoeckley, Thomas R. (Cambridge Observatories, Eng.). Mon. Notic. Roy. Astron. Soc., 140: 149-54(1968).

Computations of equivalent widths of the absorption lines of He I 4471 and Mg II 4481 in early-type main sequence stars with various rotational velocities and viewed at different angles of inclination are presented. The results of this investigation suggest that it is impracticable to use absorption line strengths to determine angles of inclination. (auth) (UK)

**45910** PULSAR MODELS. Cocke, W. J.; Cohen, Jeffrey M. (Goddard Space Flight Center, New York). Nature (London), 219: 1009-12(Sept. 7, 1968).

A model for pulsars based on vibrating white dwarf stars accounts for a number of the features of the emissions, and also gives rise to the possibility of optical fluctuations having a period twice that of the radio pulses. (auth) (UK)

**45911** QUASARS. Kafka, Peter (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Naturwissenschaften, 55: 248-54(June 1968). (In German).

A bibliographic review is given of observational and theoretical data on quasars that pertain to the question of whether quasars have a place in the series of previously known cosmological objects or whether they will revolutionize physics. The most important observations are summarized. The distance of quasars is discussed. Proposed theoretical relations between normal galaxies, radio galaxies, and quasars are considered. Quasar models with cosmological constants are given and extensions to these models are discussed. 72 references. (J.S.R.)

**45912** TEMPORAL DEVELOPMENT OF THE COMPONENTS OF A DOUBLE STAR. Kippenhahn, R.; Weigert, A. (Univ., Goettingen, Ger. Max-Planck-Institut fuer Physik und Astrophysik, Munich). Naturwissenschaften, 55: 241-7(June 1968). (In German).

Development calculations were carried out at the Max-Planck Institut für Physik und Astrophysik and at the Universitäts-Sternwarte in Göttingen for double stars. The sequence of the computer program developed is outlined. Three cases for the beginning of mass exchange in double-star systems are summarized, and examples are given of the calculation of each. (J.S.R.)

**45913** IS THE PROBABILITY OF OCCURRENCE OF ABSORPTION LINES IN QSOs A FUNCTION OF RED SHIFT? Weymann, R. J.; Wilcox, R. C. (Univ. of Arizona, Tucson). Nature (London), 219: 1031-2(Sept. 7, 1968).

It has been noted that the occurrence of absorption lines in quasars appears to increase with increasing red shift (z), suggesting that quasars with high red shift have intrinsically different properties from those with low red shift. Correlations of absorption lines with emission red shift were found using all observed absorption lines, but it is possible that these correlations were merely the result of stronger lines being brought into the observable spectrum with increase of red shift. A proper test for such correlations requires the use of a single line, or else the difference in strengths of lines in different parts of the spectrum should be allowed for. Evidence was first sought for a correlation between occurrence of the C IV λ1549 resonance line and z. This line was used because it is the absorption line which has been observed in the largest number of quasars and because it is available for a relatively large z range. No such correlation was found. As a second test the Mg II λ2798 and Si II λ1265, 1816 lines were used to compare absorption lines at small and large values of z. The relative strengths of λ2798 and λ1816 were checked when either appeared in absorption and the other was accessible, by observations on the quasar PKS 0237-23; the amounts of Si II and Mg II were found to be nearly the same, leading to the assumption that Mg II λ2798 and Si II λ1265, 1816 should all be of approximately equal strength in quasars. If there is no dependence on z, Mg II and Si II would be expected to be seen in absorption roughly equally often; they should be seen less often than C IV because carbon is more abundant by a factor of 10 and because most of the Si and Mg is ionized beyond the second stage. It is pointed out that the statistics were too small to establish that there is definitely no correlation, but the Mg II–Si II comparison appears to demonstrate that there is nothing particularly anomalous about the small number of absorption lines in quasars of small z. Overall, the results lead to the conclusion that there is no evidence that the true occurrence of absorption lines in quasars is a function of red shift, the higher percentage of absorption line quasars at high z probably being a result of the fact that a limited region of the spectrum is accessible to observation. (UK)

**45914** SEARCH FOR RADIO EMISSION FROM HARO'S BLUE GALAXIES AT 9.26 cm. Seaquist, E. R. (Univ. of Toronto); Bell, M. B. Nature (London), 219: 1032-3(Sept. 7, 1968).

Haro (1956) reported galaxies with nuclei abnormally bright in the blue region of the spectrum. Kiang (1967) reported that some of these galaxies show jets or a system of filaments, and suggested that this structure is similar to that in the giant elliptical galaxy Virgo A and the quasar 3C 273, both radio objects of much interest. In view of this it was decided to search for radio emission from the 44 galaxies in Haro's list. Observations were made in December 1967 and March 1968 with the 46-m Algonquin telescope, using a tunnel diode receiver operating at a wavelength of 9.26 cm. Results for flux densities are tabulated, and scanning results for H.10, optically the brightest galaxy, are shown graphically. The distribution of radio indices for normal spiral galaxies is shown nomographically for purposes of comparison. H.1, H.5, and H.10 showed flux densities about four times the probable error, and H.2 about 2.6 times the probable error. Investigation was made of the probability of chance coincidences. It was concluded that radio emission is associated with these galaxies, H.1, H.2 and H.5 showing much stronger radio emission than normal galaxies, and being more characteristic of some of the Seyfert galaxies. No radio emission was detected from those galaxies listed by Kiang as having jets or filaments. (UK)

**45915** UPPER LIMITS ON UNIVERSAL MICROWAVE RADIATION BELOW λ = 1.7 mm. Apparao, M. V. K. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature (London), 219: 709-10(Aug. 17, 1968).

It is pointed out that there are no direct experimental measurements of microwave radiation below a wavelength of 7 mm, which would indicate whether the radiation is "blackbody" of temperature 2.7°K ("big-bang" theory) or of a type resulting from the superposition of "sources" or the scattering of source radiation by "dust grains" (steady-state Universe interpretation). The present author derived upper limits on the intensity of the microwave radiation below λ = 1.7 mm from cosmic-ray data. Collision of high-energy protons with microwave photons leads to production of electron–positron pairs and pions, and to degradation of proton energy. The monochromatic brightness of the microwave photons

of wavelengths <1.7 mm was calculated taking the lifetime of the protons as either the Hubble time ($10^{10}$ yr) or the cosmic-ray lifetime ($50 \times 10^6$ yr). It is assumed that the proton differential energy spectrum between $10^{14}$ and $10^{20}$ eV has, at injection, a single exponent of 2.6, and that the change in shape and the reduction of particle intensity are due entirely to interaction with the microwave radiation. The upper limits for the microwave intensity for the photopion process set by use of the cosmic-ray lifetime are shown graphically. Assumption of the Hubble time would lead to intensities close to zero. Consideration of the pair production process with a Hubble time, however, yields calculable upper limits which are also shown graphically. Application to the Crab Nebula is discussed. It was evident that the microwave spectrum in the experimentally measured regions is not of the same form below 2 mm. Results were consistent with a "blackbody" spectrum with a temperature of 3°K. (UK)

**45916** MAGNETIC CHARGE OF THE PROTON AND NEUTRON. Palmer, R. F.; Taylor, J. G. (Queen Mary Coll., London). Nature (London), 219: 1033-4(Sept. 7, 1968).

Reference is made to Dirac's (1931) discussion of the monopole—the magnetically charged counterpart of the electron—and efforts made to look for it. The monopole charge envisaged would be very large, and would be expected to give rise to effects of strength similar to strong interactions. There has been recent evidence, however, of the existence of monopoles with magnetic charge lower than that allowed by Dirac's argument and, whilst the evidence is not conclusive, it seemed worthwhile to consider the possibility that monopoles can exist with any value of magnetic charge. The question of upper limits on the magnetic charge on the known elementary particles is discussed, and reference is made to Sandars (Contemp. Phys. 7: 419(1966)) who used the radial magnetic field of the Earth to deduce an upper limit on a linear combination of the magnetic charge on the proton and the neutron; this upper limit, in terms of the number of protons and neutrons in the Earth, and the Earth's radius, is given by $(N_p g_p + N_n g_n)/R_e^2 < 1$ gauss, from which an upper limit on the combination $g_p + g_n$ may be derived. In order to deduce separate limits on $g_p$ and $g_n$ it must be assumed that $g_p = g_n$, or that the electron's neutrino carries no charge. In order to remove this assumption a large body, such as the Sun, having an excess of protons over neutrons, must be considered. A model is discussed assuming that the Sun's radial magnetic field is in part due to the magnetic charge of the protons and neutrons and partly due to the vortex motion of ions in the solar atmosphere, the average magnetic field due to these vortices being zero, however, over the whole solar surface. Solar field magnetographs during periods of sunspot inactivity were examined, to investigate if there was any systematic shift consistent with a constant contribution superimposed on the vortex contribution; no such shift could be detected, and if there was such a shift it was <1 gauss. From these findings it is deduced that the proton and neutron are magnetically neutral and, making use of charge conservation in elementary particle processes, it is shown that all other elementary particles are magnetically neutral to the same limit ($<10^{-38}$ emu) except for the $\mu$-meson and its neutrino. The suggestion that the $\mu$-meson is differentiated from the electron by possessing magnetic charge is mentioned. (UK)

**45917** INVESTIGATION OF LIMB FLARE OF JULY 23, 1960. Kurochka, L. N. Soln. Dannye, No. 3, 70-6(1966). (In Russian).

A flare spectrum was photographed with a diffraction spectrographic camera (dispersion 0.8 and 1.2 mm). The emission lines Ha—N of hydrogen and H and K of Ca II were measured photometrically. The data analysis shows that the energy reserve of eddies is sufficient to insure the luminescence of flares in the visible region of the spectrum. It is concluded that a flare consists of individual "granules" (high-density sectors responsible for the emission observed), the macrocosmic movements of which appear in the form of eddies within the flare. (ATD)

## Atomic and Molecular Physics

*Refer also to abstracts 45028, 45508, 46199, 46351, 46416, 46513, 46516, 46519, 46776, 46793, 46827, 46834, and 46835.*

**45918** (AERE-R-5731) SURVEY OF THE FIRST SPECTRUM OF PROTACTINIUM. Richards, E. W. T.; Stephen, I.; Wise, H. S. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 158p. Dep. CFSTI. UK 21s, 0d.

The emission spectrum of protactinium was measured from 3 microns to 4,000 Å. Some 14,000 lines have been recorded and about half of these fitted into a level system of some 200 even levels and 300 odd levels. This level system is based on that suggested by Giacchetti (J. Opt. Soc. Amer., 56: 653(1966)), additional levels being confirmed by at least 6 spectral lines. Probable J values are given where possible, and in some cases the limits given in previous work have been reduced. (auth)(UK)

**45919** (AWRE-O-33/68) COMPTON CROSS SECTION. Warham, A. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1968. 28p. Dep. CFSTI. UK 4s, 0d.

A formula for the cross section for the Compton scattering of a photon by a gas of electrons is found and evaluated for several incident and final photon energies and several temperatures. As a check, the rate at which energy is lost by a gas of photons in collision with a gas of electrons is calculated, and found to agree with previous results in the limit of low temperatures. (auth)(UK)

**45920** (JINR-P13-3901) $\pi^-$-MESON CAPTURE IN THE MIXTURE OF HYDROGEN WITH OTHER GASES. Petrukhin, V. I.; Prokoshkin, Yu. D.; Suvorov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 18p. (In Russian). Dep.

The $\pi^-$-meson transfer from hydrogen to heavier Z elements in the gas mixture $H_2$ + Z was investigated. The capture probability is proportional to the Z nucleus charge and depends only on the relative concentration of Z atoms. The observed capture peculiarities can be explained within the phenomenological model. (auth)

**45921** (JINR-P15-3964) MEASUREMENT OF pp$\mu$-MOLECULE FORMATION RATE IN GASEOUS HYDROGEN. Budyashov, Yu. G.; Ermolov, P. F.; Zinov, V. G.; Konin, A. D.; Mukhin, A. I.; Oganesyan, K. O. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 25p. (In Russian). Dep.

Muonic molecule formation rate in gaseous hydrogen was measured. The method used was the analysis of the time dependence of muonic deexcitation x rays, originating due to the muon transfer from p$\mu$ atoms to the small amount of xenon admixture. The value obtained for the pp$\mu$-molecule formation rate is $\lambda_{pp\mu} = (2.74 + 0.25)\ 10^6\ sec^{-1}$ (at hydrogen density $\rho = 0.070\ g/cm^3$). (auth)

**45922** (N-68-25285) TRANSMISSION OF 2.43-MeV ELECTRONS THROUGH THICK SILICON TARGETS. Singh, Jag J. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Sept. 2, 1967. 25p. (CONF-670951-3; NASA-TM-X-60492). CFSTI.

From American Institute of Physics Summer Meeting, Seattle, Wash.

The energy and angular distribution of electrons transmitted through silicon targets of various thicknesses were measured for normally incident electrons of energy 2.43 MeV. The transmitted electron spectra were measured with 5-mm-deep Si(Li) detectors. The effects of secondary electrons and photons besides the effects of ionization energy loss fluctuations are also considered. The inclusion of these effects in the theoretical calculations has improved the agreement between the theory and the experiment considerably. The electron diffusion length in silicon at 2.43 MeV was measured to be (2.50 ± 0.10) mm. (auth)(STAR)

**45923** (NP-tr-1688) ELEMENTARY PROCESS OF BREMSSTRAHLUNG PRODUCTION. Nakel, W. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Phys. Lett., 25A: 569-70(1967). 4p. Dep. UK.

Handwritten MS copy.

By using a coincidence method the angular distribution of bremsstrahlung is measured for a definite energy loss and a definite angle of the outgoing electron. A comparison with theoretical predictions is given. (auth)

**45924** (TID-24666, pp 69-75) ELECTRON MOBILITY, COLLISION FREQUENCY, AND MEAN-FREE PATH IN ARGON. Rogoff, G. L. (Massachusetts Inst. of Tech., Cambridge).

The average mobility, frequency of collision for momentum transfer, and mean-free path for electrons with a Maxwellian electron energy distribution in Argon were computed as a function of electron temperature by numerical integration. The results of these calculations are presented together with comparisons of these results with estimates based on a crude approximation to the collision cross section dependence on electron energy. Also presented are simple relations between the collisional parameters and electron temperature which closely approximate the numerically computed values. (M.O.W.)

**45925** (UCRL-17392(Rev.)) PENETRATION OF HIGH-ENERGY HEAVY IONS, WITH THE INCLUSION OF COULOMB, NUCLEAR, AND OTHER STOCHASTIC PROCESSES. Litton, Gerald M.; Lyman, John; Tobias, C. A. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 100p. Dep. CFSTI.

A general method has been developed for calculating Bragg

curves, flux curves, and energy spectra resulting from the transport of high-energy heavy-ion beams in arbitrary media. The method takes into account the processes of energy loss from both electronic and nuclear elastic collisions, nuclear attenuation, small-angle multiple scattering, and straggling, as well as effects due to initial energy and angular spreads of the beam. Contributions from secondary particles are not included. Calculations are made for ions of various atomic numbers and energies incident on different targets. It is found that for a given range in a particular target, the peak-to-plateau dose ratio goes through a maximum as the atomic number of incident ions increases. Similarly, the Bragg peak full width at half-maximum goes through a minimum. Another significant result is that for a given particle range, the average energy per atomic mass unit at the Bragg peak is nearly independent of the bombarding ion, and also of the target material. The calculated results agree very well with experimental data for those cases in which secondary-particle production is of minor importance. In addition, even when secondaries are a large contributing factor, the method yields valuable information regarding the variation in energy deposition by the primary particles. The calculated results are found to be quite sensitive to the degree of angular and energy spreading of the initial beam. (auth)

**45926** (UCRL-18127) STOPPING POWER AND RANGE FOR ANY NUCLEUS IN THE SPECIFIC ENERGY INTERVAL 0.01- TO 500-MeV/amu IN ANY NONGASEOUS MATERIAL. Steward, Palmer G. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1968. Contract W-7405-eng-48. 171p. Dep. CFSTI.

Thesis.

A method is presented for calculating range and stopping-power data for any heavy ion with $0.01 \leq \epsilon \leq 500$ MeV/amu incident upon any nongaseous stopping medium. The method is incorporated into a FORTRAN IV computer program. Results for H, $^{4}$He, $^{12}$C, $^{20}$Ne, $^{40}$Ar, $^{84}$Kr, $^{131}$Xe, and $^{222}$Rn ions each incident upon $H_2O$, Al, Cu, Ag, Pb, and U are presented. For ions at low energy with $Z \leq 10$, the program uses experimental data. For ions with $Z > 10$, the nuclear and electronic stopping-power theory developed by Lindhard et al., is adjusted to fission-product range data at low energy; for intermediate energies, charge-state data developed from experimental Ar range–energy data in Al is extended to other ions and stopping media. Bethe's theory is used for all ions at high energy. Bloch's theory is discussed, although it is not used in the method. The particle ranges calculated by the method are path-length ranges and do not include the effects of multiple scattering. A method for calculating projected range at low energies is presented as an appendix. (auth)

**45927** RECOMBINATION, ATTACHMENT, AND DIFFUSION STUDIES IN NITRIC OXIDE AND CARBON DIOXIDE. Weller, Charles Stagg Jr. Pittsburgh, Univ. of Pittsburgh, 1967. 80p.

Thesis.

Photoionized plasma afterglows of NO were studied by combined microwave and mass spectrometric techniques. Nitric oxide–neon mixtures (5 to 65 mtorr NO, 2 to 7 torr Ne) were contained in a 10-cm resonant cavity where they were ionized by a "single-pulse" of Lyman $\alpha$ radiation. A temporal spectrum of ions diffusing to the wall was obtained by a differentially pumped mass spectrometer and multichannel analyzer. Analysis of the electron density decay curves obtained by microwave techniques to obtain an electron–ion recombination coefficient for $NO^+$ is complicated by the conversion of $NO^+$ to the dimer ion, $(NO)_2^+$. At sufficiently low densities of nitric oxide the $(NO)_2^+$ concentration becomes negligible, and the $NO^+$ wall current follows the electron density decay. From comparisons of experimental electron density decay curves with computer solutions of the electron continuity equation, the values $\alpha[(NO^+)] = (7.4 \pm 0.7)$, $(4.1^{+0.5}_{-0.4})$, and $(3.1 \pm 0.3) \times 10^{-7}$ cm$^3$/s, at T = 200, 300 and 450°K, respectively, are obtained. From analysis of electron density decay curves at higher densities of NO where $(NO)_2^+$ is the dominant ion the value $\alpha[(NO)_2^+] = (1.7 \pm 0.4) \times 10^{-6}$ cm$^3$/s at T = 300°K is obtained. The three-body electron attachment and ambipolar diffusion coefficients were measured in pure NO (0.1-5 Torr) and are found to be $K = (1.3 \pm 0.1) \times 10^{-31}$ cm$^6$/s and $(D_a p) = (80 \pm 16)$ cm$^2$-Torr/s, respectively, at T = 300°K. Electron–ion recombination in $CO_2$ was studied using a slightly modified form of the apparatus. Carbon dioxide–neon mixtures (typically 0.5 mTorr $CO_2$, 10 Torr Ne) were ionized by a microwave discharge. Under conditions where $CO_2^+$ is the dominant ion, the value $\alpha[CO_2^+] = (3.8 \pm 0.5) \times 10^{-7}$ cm$^3$/s at T = 300°K was found. At T = 200°K, without ion identification, the recombination coefficient was estimated to be $4 \times 10^{-7}$ cm$^3$/s. (Diss. Abstr.)

**45928** MEASUREMENTS OF 2p–1s LINE WIDTHS IN LOW-Z PIONIC ATOMS. Harris, Robert Joseph Jr. Williamsburg, Va., Coll. of William and Mary, 1968. 140p.

Thesis.

The natural line widths of 2p–1s transitions in low-Z pionic atoms have been measured using high-resolution lithium-drifted silicon [Si(Li)] and germanium [Ge(Li)] detectors. High resolution was achieved by developing a low-noise cooled FET preamplifier, which allowed the inherently good resolving capability of Si(Li) and Ge(Li) detectors to be more fully exploited than was previously possible. The instrumental resolution as measured with muonic x rays was 0.62 keV (fwhm) at 33 keV for the Si(Li) spectrometer, and 1.1 keV (fwhm) at 75 keV for the Ge(Li) spectrometer. Pionic atoms were formed by stopping negative pions in the following targets: $^{6}$Li, $^{7}$Li, $^{9}$Be, $^{10}$B, $^{11}$B, and $^{12}$C. The results obtained for pionic 2p–1s natural line widths were: $\Gamma(^{6}\text{Li}) = 0.15 \pm 0.05$ keV, $\Gamma(^{7}\text{Li}) = 0.19 \pm 0.05$ keV, $\Gamma(^{9}\text{Be}) = 0.58 \pm 0.05$ keV, $\Gamma(^{10}\text{B}) = 1.68 \pm 0.12$ keV, $\Gamma(^{11}\text{B}) = 1.72 \pm 0.15$ keV, and $\Gamma(^{12}\text{C}) = 3.25 \pm 0.15$ keV. Theoretical values for the natural line widths were computed from the theory of Ericson and Ericson and found to be in good agreement with the above-measured results. (Diss. Abstr.)

**45929** SUPER PERTURBATION THEORY AND BOUNDS ON ELECTRON–HYDROGEN SCATTERING. Madan, Rabinder Nath. Princeton, N. J., Princeton Univ., 1967. 74p.

Thesis.

A formulation of super perturbation theory for scattering on two novel approaches for evaluating phase shifts is developed. An elegant mathematical formalism for the most general Schroedinger equation is explored. A theoretical error is determined by calculating upper- and lower-bound phase shifts by a rigorous treatment of $e^-$-H s-wave scattering in the triplet state as a test of a certain kind of variational method. A maximum reducible error of 3 percent is reported. (Diss. Abstr.)

**45930** EXCITATION PROCESSES IN HELIUM. Jobe, John Dewey. Norman, Okla., Univ. of Oklahoma, 1968. 113p.

Thesis.

Helium gas has been bombarded by electrons under controlled conditions of pressure, temperature, electron energy, and beam current. Radiation rates from 51 transitions have been measured over the spectral range of 3230 to 20,582 Å. The apparent cross sections of the $2^1P$ and $2^3P$ states have been examined in the light of new and detailed information concerning the states that cascade to the 2P states. Excitation functions have been obtained for the 2P states from onset to 500 eV and for 22 of the cascading states near onset. Cascade corrections to the $2^3P$ and $2^1P$ states and imprisonment corrections to the latter have yielded values for direct electron-excitation cross sections to these states. The oscillator strength for the $2^1P \rightarrow 1^1S$ transition has been calculated. The $2^3S$ excitation function reported in the literature has been corrected for cascade using the $2^3P$ apparent cross section. The pressure dependence of apparent cross sections has been obtained at 100 eV for $^1$P states up to n = 10, the $^1$D and $^3$D states up to n = 13, and 4F. Apparent cross sections at this energy and 63 pressure have been obtained for higher F states to n = 9. It is shown that the 3D states are not involved in collisional excitation transfer. It is proposed that the 4D states receive excitation transfer from the 4F state. It is further shown that the 4F state may receive considerable G-state cascade in addition to collisional population from the $4^1P$ state. Transfer cross sections are calculated on the basis of various population equations. The temperature dependence of the apparent cross sections of the $4^1P$, $3^3D$, and $4^3D$ states has been obtained. Assuming the collisional depopulation of the $4^1P$ state is to the 4F, the transfer cross section thus obtained is proportional to the gas temperature up to about 1000°K. (Diss. Abstr.)

**45931** CALCULATION OF IONIZATION CROSS SECTIONS OF ATOMS DURING ENERGETIC-ELECTRON IMPACT. III. IONIZATION CROSS SECTIONS OF Na, Mg, Al, Si, P, S, Cl, AND Ar. Gaudin, Albert; Botter, Rene (CEN de Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 65: 1126-8(June 1968). (In French).

The preceding calculations of ionization cross sections by electron impact have been extended to the elements Na, Mg, Al, Si, P, S, Cl, Ar. For the ground states Slater wave functions are used. Comparisons with experiment are made for Na and Ar. For Na, the results, as in the case of Li, differ by a factor of 2 from the experimental results. For Ar, the results are about 30% higher than the experimental results. For comparison with the results given in the second part, the values of the dipole terms $|M^1_{nl}|^2$, $|M_l|^2$ and of the constants $C^1_{nl}$, $C_l$ for He, Li, Be, B, C, N, O, F, Ne are calculated using the Slater wave functions. (auth)

**45932** CALCULATION OF IONIZATION OF ATOMS DURING ENERGETIC-ELECTRON IMPACT. II. IONIZATION CROSS SECTIONS OF He, Li, Be, B, C, N, O, F, AND Ne. Gaudin, Albert; Botter, Rene (CEN de Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 65: 1118-25(June 1968). (In French).

The ionization cross sections for singly charged ions of He, Li, Be, B, C, N, O, F, and Ne have been calculated according to the preceding method (first part) derived from the Bethe theory. For the ground states hydrogen-like wave functions of Morse, Young

and Haurwitz were used. The ejected electron is represented by a Coulomb function, the charge of the scattering center being taken equal to 1 (total screening). The results obtained are in satisfactory agreement with the experimental results. (auth)

**45933** CALCULATION OF IONIZATION CROSS SECTIONS OF ATOMS DURING ENERGETIC-ELECTRON IMPACT. I. ESTABLISHMENT OF FORMULAS. Gaudin, Albert; Botter, Rene (CEN, Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 65: 1112-17 (June 1968). (In French).

The dipole approximation proposed by Bethe for the calculation of the cross sections for inelastic electron–atom collisions, introduces a significant error in the calculation of the ionization cross section. In the case of atomic hydrogen, the observed difference between the calculation with this approximation and the exact calculation is about 40% for incident electron energies up to several keV. When using the dipole approximation, one neglects the cross section corresponding to the collisions in which the incident electron is scattered with large momentum transfer. An approximate calculation for this cross section is proposed, which, when added to a calculation based on the dipole approximation, accounts for the entire range of collisions. The results obtained by this method for atomic hydrogen are in agreement with the exact calculation. (auth)

**45934** IONIZATION OF $CH_4$ AND $CD_4$ ON IMPACT OF 2 $^3S$ AND 2 $^1S$ HELIUM ATOMS. Herce, J. A.; Penton, J. R.; Cross, R. J.; Muschlitz, E. E. Jr. (Univ. of Florida, Gainesville). J. Chem. Phys., 49: 958-9(July 15, 1968).

Measurements of the relative product ion abundances in the Penning ionization of $CH_4$ and $CD_4$ on impact of $2^3S$ and $2^1S$ He atoms were made. For both metastable atoms the $CH_3^+$ or $CD_3^+$ ion was most abundant; $CH_4^+$, $CD_4^+$, $CH_2^+$, and $CD_2^+$ ions were also observed. Fragmentation was significantly greater for the higher-energy singlet metastable atom. No marked isotope effect was observed. (A.G.W.)

**45935** DEPOSITION OF NIOBIUM THIN FILMS BY dc DIODE AND SUBSTRATE BIAS SPUTTERING. Sosniak, J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 4157-63(Aug. 1968).

The room-temperature properties of sputtered niobium films can be made to approach those of the bulk metal either by deposition after extensive presputtering on substrates heated to ~700°C, or by the application of a small negative bias to unheated substrates. The effectiveness of the former method is associated with the crystallization of the films in the bcc form of bulk niobium and the absence of the high-resistivity tetragonal form found in sputtered tantalum films ($\beta$-Ta). High substrate temperature is a critical factor in both the purity and degree of orientation of the film. Bias sputtering reduces the impurity content of the films both as a result of low-energy ion bombardment and considerable enhancement of the deposition rate with increasing negative bias. (auth)

**45936** OVERLAPPING ATOMIC MULTIPLETS. Judd, B. R. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-1447. J. Opt. Soc. Amer., 58: 1311-12(Sept. 1968). (NYO-1447-40).

Multiplet structures characteristic of Russell–Saunders coupling are expected to disappear as soon as adjacent multiplets begin to overlap. That this is not always true can be seen from the overlapping multiplets of Pr III $4f^25d$, which obey the Landé interval rule. A theorem and its proof are presented to explain this effect. The spin-orbit coupling constants of Pr III $4f^25d$ are calculated to be $\zeta(4f) = 775\ cm^{-1}$ and $\zeta(5d) = 721\ cm^{-1}$. For UI $(5f^36d7s^2 + 5f^36d^27s)$, $\zeta(5f) = 1773\ cm^{-1}$ and $\zeta(6d) = 1145\ cm^{-1}$ are calculated, and several of its multiplets show regularity. (D.L.C.)

**45937** PRESENT STATE OF ANALYSIS OF THE FIRST SPECTRUM OF THORIUM (Th I). Zalubas, Romuald (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer., 58: 1195-9(Sept. 1968).

To date 268 even and 255 odd atomic energy levels in Th I have been found. The lowest level of the configuration $5f6d7s^2$ is $^3H_5^0$ and lies 7795.27 $cm^{-1}$ above the ground level $^3F_2$ of $6d^27s^2$. Some levels of $5f6d^27s$ and $6d^27s7p$ are identified. (auth)

**45938** EXCITATION OF K-SHELL ELECTRONS IN Be BY SOFT X RAYS AND 20-keV ELECTRONS. Swanson, N.; Codling, K. (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer., 58: 1192-4(Sept. 1968).

The soft x-ray absorption spectra of Be and BeO were measured near the K edge using the NBS 180 MeV synchrotron as a background continuum source. The energy-loss spectrum of 20-keV electrons transmitted through thin Be films at zero scattering angle was measured in the corresponding 100 to 170-eV energy-loss range. The K edges of Be and BeO measured by x-ray absorption were at 112.1 ± 0.2 eV and 118.4 ± 0.2 eV, respectively. The Be K edge in the electron-energy-loss spectrum was at 111.7 ± 0.4 eV. The positions of maxima in the absorption fine structure determined by the two techniques were also in good agreement. (auth)

**45939** NUCLEAR QUADRUPOLE MOMENT OF $^{40}K$ FROM RESONANCE RADIATION INVESTIGATIONS OF 4p $^2P_{\frac{1}{2}}$- AND 5p $^2P_{\frac{1}{2}}$-TERMS IN K I-SPECTRUM. Ney, J.; Repnow, R.; Bucka, H.; Svanberg, S. (Technische Univ., Berlin). Z. Phys., 213: 192-201(1968). (In German).

Resonance scattering of light as function of magnetic field has been used to investigate the hyperfine structure of the 4p $^2P_{\frac{1}{2}}$ and 5p $^2P_{\frac{1}{2}}$ terms in the potassium I spectrum, using a sample enriched in the $^{40}K$ isotope. With increasing magnetic field strength a structure containing two characteristic signals for $^{40}K$ was observed. Taking into account the small ratio of hyperfine-structure splitting to radiation width, these signals could be interpreted as an overlapping of three level crossings. The line shape and magnetic field strength of these signals can be understood by taking for the magnetic interaction constants $A^{40}(4p\ ^2P_{\frac{1}{2}}) = (-7.59 \pm 0.06)$ Mc/s, $A^{40}(5p\ ^2P_{\frac{1}{2}}) = (-2.45 \pm 0.02)$ Mc/s and the electric quadrupole coupling constants $B^{40}(4p\ ^2P_{\frac{1}{2}}) = (-3.5 \pm 0.5)$ Mc/s, $B^{40}(5p\ ^2P_{\frac{1}{2}}) = (-1.1 \pm 0.2)$ Mc/s using $g_j = 4/3$. The values of B/A yield with Sternheimer corrections for the nuclear electric quadrupole moment $Q(^{40}K) = -0.07 \cdot 10^{-24}\ cm^2$. (auth)

**45940** NEW LINES IN THE L-SPECTRUM OF $^{65}Tb$. Nigam, A. N.; Garg, K. B. (Univ. of Rajasthan, Jaipur, India). Naturwissenschaften, 55: 340(July 1968).

The L-emission spectrum of terbium was investigated in the medium- and long-wavelength regions. Weak but distinct lines were found at 2094.8, 1718.8, and 1711.9 x.u. (J.W.R.)

**45941** IONIZATION OF $CO_2$, $C_2H_4$, AND $C_2H_2$ BY LOW-ENERGY HEAVY IONS. Boring, J. W.; Woods, F. R. (Univ. of Virginia, Charlottesville). Contract AT(40-1)-2911. Radiat. Res., 35: 472-8(1968).

The total ionization produced by 25- to 50-keV $H^+$, $O^+$, and $Ar^+$ ions when stopped in $CO_2$, $C_2H_4$, and $C_2H_2$ gases was measured. The average energy required to produce an ion pair (W) was obtained from these measurements and compared to alpha-particle and alpha-recoil results. Calculation for $CO_2$ of the energy ultimately going into kinetic energy of gas atoms indicates that the competition between ionization and excitation remains roughly the same at keV energies as it is at MeV energies, but that for the heavy ions a large fraction of the initial energy goes into this kinetic energy of gas atoms. (auth)

**45942** POLARIZATION EFFECTS IN INDUCED EMISSION OF BREMSSTRAHLUNG. Kolbenstvedt, Hans; Olsen, Haakon A. (Norges Tekniske Hoegskole, Trondheim, Norway). Ark. Fys. Seminar Trondheim, No. 9, 10p.(1968).

The effect of induced bremsstrahlung is studied with respect to photon intensity and polarization. It is shown that the polarization effect is of importance when net induced emission occurs. (auth) (Norway)

**45943** NEW EVALUATION OF MEAN EXCITATION ENERGIES FOR USE IN RADIATION DOSIMETRY. Dalton, Patricia (Oak Ridge Associated Universities, Tenn.); Turner, J. E. Contract W-7405-eng-26. Health Phys., 15: 257-62(Sept. 1968). (ORNL-P-3547).

Atomic mean excitation energies (I values) were obtained from stopping-power and range data in twelve experiments. The analysis incorporates new values of shell corrections that include contributions made by electrons in all shells. Except for one set of data, the values of I obtained from different experiments were consistent with one another. Empirically, it was found that the following formulas fit the I values obtained: $I(eV) = 11.2 + 11.7\ Z$ for $Z \leq 13$; $I(eV) = 52.8 + 8.71\ Z$ for $Z > 13$. The numerical values found from the experiments analyzed are in agreement with those suggested in the National Academy of Sciences-National Research Council Report 1133. It appears that a few of the I values given in the National Bureau of Standards Handbook 79 (1961) are now out of date. A table of I values for some thirty-six materials of particular importance in radiation dosimetry is given, in addition to the elemental I values found from the new data analysis. (auth) (UK)

**45944** EFFECTIVE CROSS-SECTION OF THE DIRECT AND STEPWISE EXCITATION OF THE SINGLE LEVELS OF CADMIUM ATOMS. Vesnicheva, G. A.; Penkin, N. P. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 7-11(Feb. 1968). (In Russian).

The experimental data, obtained from the investigation of positive discharge column in Cd I, made it possible to find effective cross sections in the maximum of the excitation function $Q\ (V_{max})$ and effective cross sections of direct and stepwise excitation, averaged according to Maxwell distribution $(\overline{Q})$, for cadmium

levels: $n^1S_0$(n = 6, 7, 8, 9), $n^1D_2$(n = 5, 6, 7) and $n^1P_1$(n = 7, 8) by electron collision. Effective cross sections for stepwise excitation were found to be as much as 10 to 20 times larger than those for direct excitation. (auth)

**45945** OPTICAL MODEL FOR THE ELASTIC COLLISIONS OF ELECTRONS WITH ATOMS. Ob'edkov, V. D. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 42-6(Feb. 1968). (In Russian).

The model of the potential scattering is considered. It allows to take into account the inelastic channels by introducing some potential. This atomic potential appears to be a complex one and by the analogy with nuclear physics this model may be called optical. The energy dependence of the optical potential is defined from the second Born approximation for the scattering amplitude. (auth)

**45946** CONDITIONS z = 0 AND PERTURBATION THEORY IN NON-RELATIVISTIC THEORY WITH SMALL BINDING ENERGY. Braun, M. A. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 12-15(Feb. 1968). (In Russian).

It is shown that in a nonrelativistic theory with a bound state of small binding energy the conditions z = 0 make it possible to use perturbation theory in the whole complex energy plane and therefore are preferable as compared to the standard description of a bound state through the Schroedinger equation. (auth)

**45947** SEMI-CLASSICAL THEORY OF ELECTRON COLLISION EXCITATION CROSS-SECTIONS OF IONS. APPLICATION TO LINE-BROADENING. Feautrier, Nicole (Observatoire de Paris, Meudon, France). Ann. Astrophys., 31: 305-9(May-June 1968). (In French).

The semiclassical theory of collisions is used in order to calculate the impact width of spectral lines broadened by inelastic electronic collisions. This study is focussed on the system (ion + electron) and is followed by an appreciation of the accuracy of the results. (auth)

**45948** COLLISION EXCITATION OF POSITIVE IONS IN $p^q$ CONFIGURATION: TRANSITIONS BETWEEN LEVELS OF THE p TERM. PART I. Blaha, M. (Astronomical Inst. of the Czechoslovak Academy of Sciences, Ondrejov, Czech.). Ann. Astrophys., 31: 311-21(May-June 1968).

Electron collision cross sections for transitions between levels of the P term in the $2p^q$, $3p^q$, 2s2p, and 3s3p configurations were calculated in a weak coupling approximation. Both Coulomb–Born and distorted wave methods (without exchange) were applied. Results are presented in tabular form. (auth)

**45949** INFLUENCE OF THE STRUCTURE OF A SUBSTANCE ON THE COINCIDENCE BREMSSTRAHLUNG SPECTRUM. Batygin, V. V. (Leningrad Polytechnical Inst.). Sov. Phys.-Solid State (Engl. Transl.), 10: 580-3(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 740-5(Mar. 1968).

The coincidence bremsstrahlung spectrum is considered in a nearly relativistic region (simultaneous recording of bremsstrahlung quantum and scattered electron). It is shown that fixing the emission angle of the bremsstrahlung quantum of a scattered electron causes a high peak to appear in the bremsstrahlung spectrum whose width is of the order of the atomic momentum ($\hbar$ = c = 1). Any maxima and minima observed in the angular distribution of electrons scattered in the substance considered also appear in the bremsstrahlung spectrum of coincidences on the background of this high peak. By way of example, the effect of the structure of a crystalline or amorphous body on the coincidence bremsstrahlung spectrum is examined. The structure of the substance influences the bremsstrahlung spectrum no less than the angular distribution of electrons after diffraction. (auth)

**45950** $NaO^+$ PRODUCTION FROM Na AND $O_2^+$ IN MERGED BEAMS. Rol, P. K.; Entermann, E. A. (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 49: 1430-1(Aug. 1, 1968).

A Na beam of 2810 eV and an $O_2^+$ beam of energy ranging from 3953 to 4354 eV were merged, resulting in relative cm energies W of the reactants ranging from 0.05 to 5 eV respectively. $NaO^+$ ions were formed with nearly the same velocity in the lab coordinate system as the reactant particles, corresponding to a lab energy near 4765 eV. The cross section for the reaction $Na + O_2^+ \rightarrow NaO^+ + O$ was found to be about $10^{-15}$ cm$^2$ at W equal to 0.05 eV and decreased to less than $2 \times 10^{-17}$ cm$^2$ at 3.5 eV. (A.G.W.)

**45951** SCATTERING OF VELOCITY-FILTERED ATOMIC BEAMS OF Ar AND Xe FROM THE (111) PLANE OF SILVER. Smith, Joe N. Jr.; Saltsburg, Howard; Palmer, Robert L. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys., 49: 1287-97(Aug. 1, 1968).

The scattering of nearly monoenergetic atomic beams of Ar and Xe from the (111) plane of silver has been studied as a function of the nominal velocity $v_0$ transmitted by a slotted-disk velocity selector (SDVS) used as a velocity filter on the incident thermal-energy (Maxwellian) beam. The selector has a velocity spread of $\pm 0.19\ v_0$ and studies were carried out over a range of $v_0$ from $2.2 \times 10^4$ to $5.3 \times 10^4$ cm/sec. The scattered beam distributions were found to be directed, corresponding closely to those of Maxwellian beams when $v_0 = \bar{v} = {}^3/_4\ (2\pi kT_B/M)^{1/2}$, the average velocity of the corresponding Maxwellian beam of temperature $T_B$. These results, together with the results of earlier scattering studies, imply that the thermal motion of the lattice is the dominant factor in producing the spatial dispersion as well as the velocity dispersion in the scattered beam that has been observed by other investigators. The most likely origin of these dispersive effects is the languidness of the collision in the sense used by Goodman to describe gas atom–lattice collisions. (auth)

**45952** CLASSICAL DIFFERENTIAL CROSS SECTIONS FOR SCATTERING FROM A REPULSIVE INVERSE-POWER POTENTIAL. Felder, R. M. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 49: 1438-9(Aug. 1, 1968). (BNL–12333).

The classical differential scattering cross section for a repulsive inverse-power potential may be written $\sigma(E,\theta)\ \sin\theta = (sK/E)^{2/s}\ \phi(\theta)$, where E is the relative kinetic energy of the colliding atoms, $\theta$ the scattering angle in the cms, and s and K the exponent and premultiplying factor, respectively, of the inverse-power potential. An n-term series expression (n = 3, 4, or 5) for $\phi$ is given. The coefficients for use in the expression and the maximum percentage errors resulting from its use are tabulated. (A.G.W.)

**45953** THEORETICAL ATOMIC TRANSITION PROBABILITIES. Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.); Garstang, Roy H. Annu. Rev. Astron. Astrophys., 6: 449-94(1968).

Permitted transitions are discussed in terms of one-configuration approximations, many-configuration approximations, Z-expansion approximations, radial transition integrals (general properties), radial transition integrals (stability), and radial wavefunctions (evaluation of key parameters). Relative transition probabilities in intermediate coupling and forbidden transitions are covered by Garstang. 112 references. (W.D.M.)

**45954** COMMENTS ON "DUOPLASMATRON ION BEAM SOURCE FOR VACUUM SPUTTERING OF THIN FILMS." Crawford, C. K. (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instrum., 39: 1390-1(Sept. 1968).

Comments are presented on the conclusions of a previous paper "Duoplasmatron Ion Beam Source for Vacuum Sputtering of Thin Films" by Chopra and Randlett (Rev. Sci. Instru. 38: 1147(1967)). An author's reply is also included. (B.G.D.)

**45955** ENERGY DISTRIBUTION OF LIGHT IONS SCATTERED BY SOLID SURFACES. Mashkova, E. S.; Molchanov, V. A.; Rakhmatulina, A. Kh. Dokl. Akad. Nauk SSSR, 181: 49-52(July-Aug. 1968). (In Russian).

Experimental data were obtained on energy distribution during scattering of 30-keV $He^+$ ions by various polycrystalline targets with various atomic and mass numbers. A mathematical analysis of the problem was carried out using transfer equations. The experiments considered the slip angle of 15° with angle of scattering from 20 to 45° at temperature of about $^9/_{10}$ of the melting temperature of copper, silver, and gold. The results showed that the transfer equations effectively describe the passage of fast ions through solids. Even approximate evaluations describe the general picture of energy distributions and the ratio of spectral widths. Moreover, correlation of the calculated data enable a certain selection of interaction potentials. (R.V.J.)

**45956** SINUSOIDAL MOLECULAR BEAM CHOPPER WITH AN INTERNALLY GENERATED PHASE REFERENCE SIGNAL. Schwarz, James A.; Madix, Robert J. (Stanford Univ., Calif.). Rev. Sci. Instrum., 39: 1366-8(Sept. 1968).

A molecular beam chopper was developed which produces a periodic beam waveform closely approximating a pure sine wave. The chopper generates a reference signal internally for the purpose of phase lag determinations. Its reliable vacuum characteristics make it ideally suited for clean systems. (auth)

**45957** LATENT SYMMETRY OF THE HYDROGEN ATOM. Perelomov, A. M.; Popov, V. S. Zh. Eksp. Teor. Fiz., 54: 1799-1805(June 1968). (In Russian).

A number of problems related to the so-called "latent" symmetry of the hydrogen atom are considered. The discrete spectrum wave functions are realized as polynomials of the two complex variables $z_1$, $z_2$ in a manner analogous to the Fock–Bargmann representation for a harmonic oscillator. It is shown that from the wave functions of the continuous spectrum of the hydrogen atom one can set up generalized "representations" of the rotation group corresponding to the complex values of the angular momentum $j = -{}^1/_2 + i\rho\ (-\infty < \rho < +\infty)$. The expansion of the direct product of

these representations is considered and it is shown that only the usual (integer) values of the momentum enter the expansion. The corresponding Clebsch–Gordan coefficients are expressed in terms of the scattering phases in a Coulomb field. (auth)

**45958** ANNIHILATION OF POLARIZED POSITRONS IN FERROMAGNETIC METALS. Sedov, V. L.; Solomatina, L. V.; Kondrashova, L. A. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 54: 1626-32(June 1968). (In Russian).

The rate of two-quantum annihilation acts during the annihilation of polarized positrons in a magnetized ferromagnet depends on the mutual directions of positron polarization and magnetization of the sample. This effects was studied in iron and nickel. The following values were obtained for the quantity $K = (N_+ - N_-)/(N_+ + N_-)$: $K_{Fe} = (1.5 \pm 1.5) \cdot 10^{-4}$, $K_{Ni} = (-0.5 \pm 1.5) \cdot 10^{-4}$. (Here $N_+$ and $N_-$ are the two-quantum annihilation rates respectively for magnetic fields directed along and opposite to the direction of positron polarization.) On basis of the results obtained conclusions are drawn regarding the polarizations of the 4s electrons of the metals. (auth)

**45959** INVESTIGATION OF $\pi^-$ MESON CAPTURE BY HYDROGEN IN HYDROGENEOUS SUBSTANCES. Krumshtein, Z. V.; Petrukhin, V. I.; Ponomarev, L. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 54: 1690-6(June 1968). (In Russian).

The probability of $\pi^-$ meson capture by hydrogen in $Z_mH_n$ hydrides and compounds of the $Z_k'Z_mH_n$ type is measured. A relative method is employed which is based on a comparison of the $\pi^0$ meson yield from the investigated targets and LiH targets. It is shown that the results can be satisfactorily described by the model of large mesomolecules. The initial capture follows the "Z law". The probability for $\pi^-$ meson capture in $Z_mH_n$ hydrides strongly varies on transition from one period to another in the Mendeleev table to which the atom Z belongs and also depends on the type of the chemical bond. (auth)

**45960** RESONANCE CHARGE EXCHANGE OF LOW ENERGY CARBON AND NITROGEN IONS. Belyaev, V. A.; Brezhnev, B. G.; Erastov, E. M. Zh. Eksp. Teor. Fiz., 54: 1720-5(June 1968). (In Russian).

The resonance charge exchange cross sections for nitrogen and carbon ions are measured between 7 and 100 eV by the overtaking beam technique. In the control experiments the resonance charge exchange cross sections for helium ions are measured in the same energy range. (auth)

**45961** RELATIVISTIC EFFECTS IN ATOMIC FINE STRUCTURE. II. Armstrong, Lloyd Jr. (Westinghouse Research Labs., Pittsburgh). J. Math. Phys. (N. Y.), 9: 1083-6(July 1968).

The methods of second quantization are used to investigate matrix elements of the Breit equation in mixed configurations. In the special case of a single configuration, the results are shown to be identical to those obtained in the previous paper of this series using equivalent operators. Application of second-quantization methods to calculations involving relativistic atomic states is shown to be extremely straightforward and to provide a simplicity and clarity unattainable using the equivalent-operator technique. (auth)

**45962** PLETHYSM AND THE THEORY OF COMPLEX SPECTRA. Smith, P. R.; Wybourne, B. G. (Univ. of Canterbury, Christchurch, New Zealand). J. Math. Phys. (N. Y.), 9: 1040-51(July 1968).

Notable progress in developing the theory of complex spectra has come from the exploitation of the symmetry properties of atomic wavefunctions using the theory of continuous groups. Many seemingly simple results have previously been obtained by what would appear to be unreasonably complex methods. Many of these complexities may be removed, and new results derived, using the algebra of plethysm first developed by Littlewood. Applications to three central problems in the theory of complex spectra are discussed: (1) the classification of the atomic stars of n-electron configurations; (2) the analysis and classification of the N-particle operators that arise in the application of perturbation theory to atomic problems; (3) the derivation of selection rules for the matrix elements of operators. (auth)

**45963** A MEASUREMENT OF THE SPIN-EXCHANGE CROSS SECTION OF $^{133}Cs$, $^{87}Rb$, $^{85}Rb$, $^{39}K$, AND $^{23}Na$. Ressler, Neil William. Ann Arbor, Mich., Univ. of Michigan, 1967. 112p. Thesis.

Measurements to determine the spin-exchange cross section for collisions between like alkali atoms are reported. The spin-exchange cross section was determined for $^{133}Cs$, $^{87}Rb$, $^{85}Rb$, $^{39}K$, and $^{23}Na$. The lifetime of the alkali atoms in the Zeeman sublevels of the ground state hyperfine levels is dominated by spin-exchange collisions. The spin-exchange collision rate is therefore reflected by the linewidth of the microwave absorption spectrum observed in the magnetic dipole transitions between various Zeeman sublevels. The measurements employed an X-band electron paramagnetic resonance spectrometer. The alkali metal was distilled into a sample bulb placed inside a dewar in a resonant cavity. The bulb was then heated to a temperature corresponding to an equilibrium vapor density of approximately $10^{15}$ alkali atoms/cc and the microwave absorption spectrum was recorded. In order to relate the spin-exchange rate to a cross section it is necessary to determine the alkali density. This was done by comparing the intensity of the alkali EPR absorption to that of a weighed and oriented copper sulfate crystal. For $^{133}Cs$ and $^{87}Rb$, interpretation of the linewidth data is complicated by the fact that the transitions occur in a region where there is appreciable mixing of the high-field spin states by the hyperfine interaction. A density matrix description of spin-exchange that corrects for this intermediate field mixing is discussed and the corrections are applied to the measured cross sections for two transitions in $^{133}Cs$ and $^{87}Rb$. The absolute spin-exchange cross sections and temperature at which the mean relative velocity was calculated are tabulated. (TSS) (Diss. Abstr.)

**45964** BINDING ENERGIES OF ELECTRONS IN THE NEXT INNER SUBSHELL OF ATOMS AND IONS FROM BORON TO ZINC. Lotz, Wolfgang (Institut fuer Plasmaphysik, Muinch). J. Opt. Soc. Amer., 58: 236-40(Feb. 1968).

Binding energies of electrons in the next inner subshell are given for most ionization stages of the elements boron through zinc (Z = 30). The binding energies of (inner) 2s and 3s electrons are calculated along isoelectronic sequences with full regard to experimental values, in the sense that experimental values are preferred in all cases of doubt. Similarities in the periodic table are taken into account. (auth)

**45965** REFLECTION OF MONOENERGETIC ELECTRONS AT 600 TO 1200 keV FROM METALS AND ALLOYS. Guglya, V. G.; Glazunov, P. Ya.; Kosukhin, V. V. (Inst. of Physical Chemistry, Moscow). Zh. Tekh. Fiz., 38: 897-901(May 1968). (In Russian).

The reflection of electrons from Ta, Cd, Nb, Ti, Ni alloy 79NM5, and three alloys of the Pb–Sn system was studied in the energy interval from 600 to 1200 keV. It was shown that for all the materials studied, the reflection coefficient decreases with increase of the initial electron energy. Reflection from the alloys was determined charge, calculated by the Mueller formula. (tr-auth)

**45966** OPTICAL PUMPING AND INTERACTION OF ATOMS WITH THE ELECTROMAGNETIC FIELD. Cohen-Tannoudji, C. (Laboratoire de Spectroscopie Hertzienne de l'E.N.S., Paris). pp 347-93 of Cargese Lectures in Physics, Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

The perturbation of oriented atoms when irradiated by light of rf photons is studied, and some effects of the real or virtual absorption of optical and rf photons are described. The interaction with topical photons is considered. It is shown, first theoretically then experimentally, how atomic sublevels in the ground state are broadened and shifted by irradiation with resonant or near resonant optical photons. The interactions with rf photons and higher-order processes involving several quanta are considered. The possibility of cancelling the Landé factor of an atom by interactions with a rf field is described, and the crossing and anticrossing of energy levels are explained. (J.F.P.)

**45967** TIMES OF AUGER DE-EXCITATION OF HOLES CREATED BY IONIC BOMBARDMENT OF A BOUND ELECTRONIC LEVEL OF AN ATOM OF THE IRRADIATED METAL. Joyes, Pierre; Hennequin, Jean-Francois (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 29: 483-7(May-June 1968). (In French).

The secondary emission due to bombardment by noble gas ions is investigated. In these conditions a deep hole in a bounded orbital of a metal atom can be created during a strong knockon. Calculations of the lifetime of this excited state within the metal are developed. Comparison of this lifetime with the slowing-down time of a displaced atom within the metal shows that it is possible to observe de-excitation, out of the target, of metastable atoms which are ejected from the sample. An experimental proof was given by the observation of an Auger peak in the energy distribution of secondary electrons. (auth)

**45968** MEASUREMENT OF THE LIFETIME OF THE $6^3S_1$ LEVEL OF CADMIUM AND COLLISION CROSS SECTIONS OF VARIOUS GASES FOR THIS LEVEL. Laniepce, B. (Faculte des Sciences, Caen, France). J. Phys. (Paris), 29: 427-33(May-June 1968). (In French).

By stepwise excitation with very bright light sources, cadmium atoms are excited in the $6^3S_1$ level. The lifetime of this $6^3S_1$ level has been determined by Hanle effect measurements (zero field

level crossing). Coherence transfers from the $5^3P_1$ level to the $6^3S_1$ level have been observed in the visible fluorescence from the $6^3S_1$ level, in good agreement with theoretical predictions. The cross-sections for depolarization of cadmium atoms in the $6^3S_1$ level by collisions with rare gas atoms are zero within experimental errors. The cross-section for nitrogen molecules is $\sigma^2 = 9.2 \pm 0.5$ Å$^2$. (auth)

**45969** RELAXATION THROUGH SPIN EXCHANGE COLLISIONS. II. Grossetete, F. (Faculte des Sciences, Paris). J. Phys. (Paris), 29: 456-66(May-June 1968). (In French).

Some new results, completing the study of spin-exchange relaxation of an alkali metal vapor, are reported here. The stationary state reached by the atomic system, energy level shifts of an atom due to collisions with different atoms, influence of collisions with identical atoms on the evolution of different observables, etc., are discussed. (auth)

## Cosmic Radiation

*Refer also to abstracts 46309, 46325, 46460, and 46464.*

**45970** PERPENDICULAR SHOCKS IN A MEDIUM CONTAINING COSMIC RAYS. Hudson, P. D. (Columbia Univ., New York). Mon. Notic. Roy. Astron. Soc., 140: 255-63(1968).

The structure of perpendicular shocks in a medium containing cosmic rays is discussed, and an equation for the compression ratio of the shock is derived. It is shown that the cosmic rays lessen the compressibility. The change in radio emission is discussed, and the study is extended to nearly perpendicular shocks. (auth)

**45971** COSMIC-RAY TRAJECTORIES IN THE GEOMAGNETIC FIELD. Lindgren, Stig (Uppsala Univ.). Ark. Geofys., 5: 197-229(1967).

A general expression is derived for the response of a cosmic-ray monitor to an arbitrary anisotropy beyond the geomagnetic field. To facilitate some applications of this expression cosmic-ray trajectories were computed for Murchison Bay, Kiruna, Uppsala, and Rome for a great number of rigidities and directions of incidence. Their general properties are discussed. Measurements with crossed telescopes at Kiruna are treated in some detail since they definitely indicate a softening of the spectrum of the diurnal anisotropy from 1958 to 1963. An explanation is given of the focusing effect and some of its characteristics are discussed. A rough but surprisingly accurate method is described to calculate cutoff rigidities in a special sense for inclined directions. The method is useful at least down to the latitude of Uppsala. (auth)

**45972** A STUDY OF INTERPLANETARY STRUCTURE AS REVEALED DURING THE COSMIC-RAY STORM IN FEBRUARY 1962. Lindgren, Stig (Uppsala Univ.). Ark. Geofys., 5: 167-95(1967).

A cosmic-ray storm lasting for seven days started on February 4, 1962. Geomagnetic storms occurred not only at the onset but also at the rather sudden recovery. Worldwide increase effects coinciding with the main phases of these magnetic storms can only partly be interpreted as due to a lowering of the geomagnetic cutoff rigidities. Between onset and recovery of the cosmic-ray storm the daily variation grows to a maximum amplitude four times the normal one, the growth being accompanied by a considerable change from early to late times of maximum. (auth)

**45973** A STUDY OF ATMOSPHERIC EFFECTS ON COSMIC-RAY RECORDS FROM PLASTIC SCINTILLATION MONITORS AT UPPSALA. Ekstroem, Lars. Ark. Geofys., 5: 129-40(1967).

Atmospheric effects on cosmic-ray records from the new plastic scintillation monitors at Uppsala were studied according to modified Duperier and Dorman models. Pressure coefficients were found for the vertical as well as the inclined directions. The two models were investigated partly by an "ordinary" or "direct" method and partly by a "successive difference" or "tendency" method. A significant difference was found for the decay coefficient in the Duperier case. The seasonal effect revealed by the "direct" method is eliminated when the "difference" method is being employed. Results from the Dorman case give a temperature coefficient not significantly different from zero in the layer 100 to 300 mb. The serial correlation of the residuals and random errors in the independent variables were also studied. These tests show that the "difference" method is the more favorable one, and that it gives more reliable results from a statistical point of view. (auth)

**45974** PERSISTENT AND TRANSIENT ANISOTROPIES OF THE COSMIC RADIATION. Ables, Jon Gordon. Stillwater, Okla., Oklahoma State Univ., 1967. 202p.

Thesis.

Data taken from the worldwide net of cosmic-ray neutron monitors, deep-space probes, and balloon-borne monitors were used to study temporal variations and anisotropies of the cosmic radiation. Analytic methods taken from the fields of the statistical theory of the communication and information theory were adapted for use with the cosmic-ray data: older methods commonly used in cosmic-ray analyses were expressed in the language of the more modern theory and improvements were suggested; new methods for the normalization of neutron-monitor data were formulated; and a technique for the production of cosmic-ray intensity-contour maps in the time-direction plane from neutron-monitor data was formulated. For the study of rapid variations in the low-energy cosmic-ray flux at high geomagnetic latitudes, a large-aperture balloon-borne cosmic-ray monitoring instrument was constructed and flown at Ft. Churchill, Manitoba, Canada. Evidence was found for a random modulation of the diurnal cosmic-ray anisotropy distinct from the general background of random variations of the cosmic-ray flux and for a 27-day periodic modulation of the diurnal anisotropy. The presence of a semi-diurnal anisotropy was verified having an amplitude of 0.14% peak-to-peak and maxima along a line perpendicular to the mean interplanetary magnetic field. A measurement of a possible sidereal anisotropy was determined to be not feasible with the presently available neutron-monitor data. The 27-day variation was detected in frequency-domain analyses and the impulsive nature of the variation demonstrated. A probable lifetime for the solar-surface phenomena responsible for this variation was determined as approximately two solar rotations. The anisotropies associated with Forbush decrease events were shown to be qualitatively and quantitatively compatible with the "blast-wave" theory of Parker. Also, the structure of the recurring decreases reportedly seen in the data from the Pioneer VI space probe was shown to be similar to the structure of solar flare induced decreases implying the presence of a standing shock in interplanetary space. Power-spectrum analysis of the data from a balloon-borne instrument flown at Ft. Churchill, Manitoba, Canada, on August 6, 1965, has indicated the presence of rapid, periodic temporal fluctuations of the cosmic-ray flux >85 MeV with periods of 280 sec and 9 sec. (Diss. Abstr.)

**45975** PROTON AND HELIUM NUCLEI COSMIC RAY SPECTRA AND MODULATIONS BETWEEN 100 AND 2000 MeV/NUCLEON. Ormes, Jonathan F. Minneapolis, Univ. of Minnesota, 1967. 93p.

Thesis.

During the years 1963–1966, as the Sun passed through its minimum period of activity, an extensive series of balloon flights has been conducted in order to study the primary cosmic radiation and its time variations. The instrument used is a Čerenkov-scintillation counter telescope, the most recent version of which contains two dE/dX detectors, a combination Čerenkov and scintillation detector and a range scintillator. This telescope and its response characteristics to protons and helium nuclei are described. Convolution techniques are used to unfold the Landau fluctuations in energy loss thereby allowing derivation of the differential energy spectrum from 100 MeV/nucleon up to 2 BeV/nucleon. The differential energy spectra derived by this technique are presented from nine balloon flights, five at Fort Churchill, Canada and four at latitudes ranging from Ely, Minnesota to Fayetteville, Arkansas. The spectra thus derived are found to be in generally good agreement with those of other workers but significantly more accurate. The spectra at lower latitudes clearly show the effects of the geomagnetic cutoff. The data is examined to determine the functional form of the solar modulation by comparing the sunspot minimum spectrum obtained in 1965 with the pre-sunspot minimum spectrum obtained in 1963 and the post sunspot minimum spectrum obtained in 1966. The modulation data does not follow a functional form of either $1/\beta$ or $1/\beta R$ but rather a form more nearly like $1/\beta R^{\frac{1}{2}}$. A theoretical picture is considered in which this behavior can be ascribed to the statistical distribution of magnetic scattering center sizes in the interplanetary medium. In this model the exponent of the rigidity dependent term in the modulation can be related to the slope of the power spectrum of magnetic scattering centers. The data is compared with that of other workers and found to be consistent with a picture in which the form of the modulation above 200 MeV/nucleon changes from $1/\beta R^{\frac{1}{2}}$ near sunspot minimum to almost $1/\beta R$ near sunspot maximum. It is also observed that, at all levels of solar modulation, there is a rigidity below which the form of the modulation becomes $\approx 1/\beta$. The rigidity below which the form $1/\beta$ holds varies systematically during the solar cycle, but differently for protons and helium nuclei in a manner which is difficult to understand within the framework of the current solar wind models for the modulation. (Diss. Abstr.)

**45976** COSMIC-RAY ANISOTROPY ASSOCIATED WITH STORM SUDDEN COMMENCEMENTS. Stensland, B. (Uppsala Univ.). Ark. Geofys., 5: 155-66(1967).

The ratio of the southern to the northern meson influx as measured in Kiruna, Malmberget, and Uppsala was found to change characteristically during the initial phase of suddenly commencing magnetic storms. The disturbances were found to be well defined, when a ssc precedes a prominent Forbush decrease. The perturbation interval starts 6 to 10 hrs before and ends about 10 hrs after the ssc. The effects were not noticed in the W–E records from Uppsala and Mawson. (auth)

**45977** EXPERIMENTAL ARRANGEMENT TO STUDY GEOMAGNETIC EFFECT OF EXTENSIVE AIR SHOWERS. Rao, A. Bhaskara. (Indian Inst. of Tech., New Delhi); Gill, P. S. Indian J. Pure Appl. Phys., 6: 307-11(June 1968).

An improved experimental set-up using two GM counter telescopes in conjunction with three core selectors (P-sets), for the study of geomagnetic effect of extensive air showers (EAS) is described. The arrangement can be utilized for determining the relative role of electronic and $\mu$-mesonic components in the geomagnetic effect of EAS. It can also be used to evaluate the geomagnetic effect as a function of the zenith angle of the secondary shower particles. Some of the merits of the present set-up are discussed. (auth)

**45978** $^{7}$Be IN OCEAN WATER. Silker, W. B. (Battelle-Northwest, Richland, Wash.); Robertson, D. E.; Rieck, H. G. Jr.; Perkins, R. W.; Prospero, J. M. Science, 161: 879-80(Aug. 30, 1968).

Concentration of the $^{7}$Be, produced by cosmic rays, was measured in waters collected from both the Atlantic and Pacific oceans. This short-lived nuclide is well suited as a tracer for interactions at the air–sea interface and for the measurement of rapid mixing processes in the surface layer of the ocean. (auth)

**45979** DISTRIBUTION OF NEUTRONS IN AIR NEAR THE EARTH'S SURFACE. Yampol'skii, P. A.; Kokovikhin, V. F.; Kondurushkin, N. A.; Bolyatko, A. V. At. Energ. (USSR), 25: 122-5(1968). (In Russian).

The spatial and time distributions of neutrons of 0.025 to 14 MeV initial energy in air close to the earth's surface is computed by the Monte Carlo method by means of electronic computer M-20. The distribution of neutrons is presented over four equal conical zones containing the whole semi-space. The tops of the cones were at the neutron source on the surface. The interval of investigated distances was 10 to 1000 m. Certain results of computation were compared with those obtained experimentally (10 figures, 11 references). (auth)

**45980** ENERGY SPECTRUM AND ANGULAR DISTRIBUTION OF THE PENETRATING COSMIC-RAY COMPONENT AT MOUNTAIN ALTITUDES. Erlykin, A. D.; Kulichenko, A. K.; Nikol'skii, S. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 320-3(June 5, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 409-12(June 5, 1968).

The characteristics of the penetrating component were determined using an ionization calorimeter and a hodoscope of gas-discharge counters at an altitude of 3340 m above sea level. In 602 hr, ~6000 events were registered, and the energy and zenith angle were determined for each cascade. The angular distributions of the cascade with $E \geq 10^{11}$, $3 \times 10^{11}$, and $10^{12}$ eV were analyzed and compared with calculations made using the assumption of a pure "pion" or "kaon" origin of the muons. The angular distribution of the muons is found to be more isotropic than that for a pure pion source. However, analysis of the energy spectra contradicts the assumption of K–$\mu$ decay in the muon production. The angular distributions of the muons with $E_\mu \geq 10^{12}$ eV are independent of their energy, and the larger isotropy can be reconciled with the assumed pion origin of the muons. The excess of cascades at energies $E \geq 6 \times 10^{12}$ eV is considered. (D.L.C.)

**45981** COMPOSITION AND ORIGIN OF COSMIC RAYS. Rees, M. J.; Sargent, W. L. W. (Univ. of Cambridge, Eng.). Nature (London), 219: 1005-9(Sept. 7, 1968).

A summary is given of the latest results on the composition of cosmic rays, and their theoretical implications, as discussed at a conference held in Cambridge during July 16–19. They point to a thermonuclear origin, but it is still a matter of speculation whether cosmic rays in the solar vicinity are produced in galactic objects such as supernovae, or whether they originate in extragalactic "violent events." (auth) (UK)

## Direct Energy Conversion

*Refer also to abstracts 46000 and 47001.*

**45982** (N-68-23476) CHARACTERISTICS OF A VARIABLE SPACED PLANAR THERMIONIC CONVERTER WITH A TUNGSTEN EMITTER AND A NIOBIUM COLLECTOR. Wilson, V. C.; Lawrence, J. (General Electric Co., Schenectady, N. Y.). May 1968. Contract NAS3-8511. 105p. (NASA-CR-1033). CFSTI.

A parallel-plane variable-spaced, thermionic converter was built with a polycrystalline tungsten emitter and a polycrystalline niobium collector. Current–voltage characteristics were obtained for a range of emitter temperatures from 1673 to 2153°K, collector temperatures from 873 to 1173°K, cesium reservoir temperatures from 583 to 683°K, and spacings from 1.0 to 20.0 mils. Over fifty families of curves consisting of over 190 load lines were obtained. Description of the converter processing procedure, test facility and experimental techniques is included. The output characteristics are compared with those of three converters with nickel collectors. (auth) (STAR)

**45983** (N-68-25059) THERMAL PERFORMANCE OF A RHENIUM NIOBIUM CYLINDRICAL THERMIONIC CONVERTER. Williams, R. M.; Bifano, W. J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1968. 26p. (NASA-TN-D-4582). CFSTI.

Efficiency and steady-state performance were measured for a cylindrical thermionic converter having a rhenium emitter and a niobium collector. Measurements were made at the cesium-reservoir temperatures at which peak output power was obtained from emitter temperatures in the range from 1873 to 2073°K and collector temperatures in the range from 850 to 1050°K. Increasing the emitter temperature from 1873 to 2073°K resulted in increasing the maximum electrode efficiency from 0.127 to 0.144. The output power at maximum efficiency increased from 5.7 to 9.2 W/cm$^2$. For fixed emitter temperatures, the emitter-to-collector heat flux increased linearly with current at the rate of 2.10 W/A. (auth) (STAR)

**45984** ELECTRICAL PROPERTIES OF XENON-FILLED THERMIONIC DIODES IN THE RADIATION FIELD OF A NUCLEAR REACTOR. Forman, Ralph (Lewis Research Center, Cleveland). J. Appl. Phys., 39: 4351-6(Aug. 1968).

The properties of xenon-filled thermionic diodes exposed to nuclear radiation in the core of a 5.0-MW nuclear reactor are described. Characteristic curves of current vs voltage are obtained as a function of various parametric changes in the radiation-induced plasma between electrodes. The parameters, which are separately varied, are electrode spacing, xenon pressure, nuclear radiation intensity, and electrode temperatures. Electrical discharge phenomena in the radiation-induced plasma were extensively studied. Breakdown at voltages much lower than the first excitation potential are described and this breakdown effect was studied as a function of the pressure of gas and the distance between electrodes. Results are also reported showing that the electrical discharge in the nuclear irradiated xenon plasma can be sustained with applied voltages as low as 1 V. (auth)

**45985** SOME DIAGNOSTIC TECHNIQUES USEFUL FOR MHD-GENERATOR PLASMAS. Wienecke, R. (Institut fuer Plasmaphysik, Munich). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1724-7(Sept. 1968).

The plasma in an MHD generator is mainly defined by its electron density $n_e$, its electrical conductivity $\sigma$, the temperatures of the gas and the electrons $T_g$ and $T_e$, its velocity v, and the value of the Hall coefficient $\omega\tau$. In recent years, various diagnostic methods have been developed in order to determine and clarify the behavior of such generators without any claim to completeness. (auth)

**45986** TRANSPORT PROPERTIES OF MHD-GENERATOR PLASMAS. Kruger, C. H.; Mitchner, M.; Daybelge, U. (Stanford Univ., Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1712-23(Sept. 1968).

The kinetic theory of partially ionized plasmas is applied to the calculation of transport properties for plasma conditions representative of MHD generators. Emphasis is placed on the accuracy of approximate formulas in comparison with the exact values. The exact values are obtained by means of spherical-harmonic expansions of the electron and heavy-particle Boltzmann equations, with the use of simplifications associated with the small electron mass. Consideration is given to both electron and heavy-particle properties in the presence of a magnetic field, including electrical and thermal conductivity, thermal diffusion, and viscosity coefficients, and allowing for differences between the electron and heavy-particle temperatures. In all cases it is found that accurate results can be obtained by simpler means than the classical Chapman–Enskog calculation, but that various approximate formulas differ significantly in their accuracy. Several new formulas are proposed. The influence on these results of differing cross sections is discussed, as are the effects of nonelastic collisions in the electron en-

ergy equation and the difference between quasi-scalar properties in a magnetic field and those that apply in the absence of, or in the direction parallel to a magnetic field. Corrections to the calculations when the plasma parameter lnΛ is not large are considered. (auth)

**45987** OPTIMIZATION STUDIES ON OPEN-CYCLE MHD GENERATORS. Carter, C.; Heywood, J. B. (Central Electricity Research Labs., Surrey, Eng.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1703-11(Sept. 1968).

An optimization theory that predicts the variation of thermodynamic properties, duct shape, and electrical loading along an MHD generator for minimum duct length, duct surface area, or duct volume is developed. The model is based on the one-dimensional flow equations including heat transfer and friction, and the analysis is developed for a fluid with arbitrary dependence of density, enthalpy, electrical conductivity, and mobility on temperature and pressure. Four types of electrical loading of the generator are considered: the segmented-electrode Faraday generator; and the cross-connected generator, first with constant cross-connection angle and multiple load connections; then with a single load; and finally with constant cross-connection angle and with single load. This theory is then applied to the design of an open-cycle MHD generator for a 2000-MW power plant. Numerical results for these four different types of generator are calculated with a computer program and compared, with particular emphasis on the loading parameter variation. It is concluded that the additional constraints of constant cross-connection angle and single load do not significantly affect the over-all generator performance, although they do modify the parameter variation along the duct. (auth)

**45988** VARIABLE-VELOCITY MHD INDUCTION GENERATOR WITH ROTATING-MACHINE INTERNAL ELECTRICAL EFFICIENCY. Elliott, David G. (California Inst. of Tech., Pasadena). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1695-1702(Sept. 1968).

A traveling-wave, MHD induction generator with varying fluid velocity between inlet and exit can have the same internal electrical efficiency as a rotating induction generator. The fraction of electric retarding work converted to electric output at each station in the flow channel is $(1 + s)^{-1}$ where s is the local slip $(U - U_s)/U_s$ between the velocity of the fluid U and the velocity of the zero-crossing of the magnetic field wave $U_s$. To produce the rotating-machine efficiency, the product of magnetic field amplitude, wave velocity, and flow channel width is held constant from inlet to exit. The local slip can be freely chosen for maximum electric output from the fluid in the presence of friction, and the inlet magnetic field can be selected for maximum output after winding and end losses. An efficiency of 0.63 is found possible with a 325-kw lithium generator. (auth)

**45989** ELECTRICAL CHARACTERISTICS OF A LINEAR, NONEQUILIBRIUM, MHD GENERATOR. Zauderer, Bert; Tate, Eric (General Electric Co., King of Prussia, Pa.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1685-94(Sept. 1968).

The purpose of this experimental study was to determine the electrical performance of a linear, segmented-electrode, MHD generator. Various noble gases were shock-heated to plasma conditions which allowed MHD generator operation with Hall parameters $\omega_e\tau_e$ ranging from 1 to 20 and ratios of electron to static gas temperatures of 1 to 2.5. For $T_e/T_g > 1$, the discharge structure in the generator was nonuniform. The major results were: (1) By comparing the experiments with an MHD generator theory that included the effect of nonuniform extrathermal ionization, it was found that the Faraday generator operated in the normal mode in which the current vector is approximately perpendicular to the axial flow direction, at all values of $\omega_e\tau_e$. The electrical performance of the generator at high $\omega_e\tau_e$ was much better than that predicted for the shorted mode of operation in which the current vector is inclined in the axial Hall direction. (2) It was found that it was possible to obtain good agreement between the experiments and a simple uniform plasma, segmented-electrode theory that included the Lorentz force effects, the electrode voltage losses, and the increased dissipation due to the plasma nonuniformities in the analyses. (3) Because of the relatively coarse electrode segmentation, it could not be established conclusively whether the effect of the electrothermal instabilities or the effect of finite electrode segmentation limited the maximum attainable Hall field. (auth)

**45990** OBSERVATIONS OF LARGE NONEQUILIBRIUM CONDUCTIVITY IN A CLOSED-CYCLE MPD CHANNEL WITH APPLIED ELECTRIC AND MAGNETIC FIELDS. Haines, M. G. (Imperial Coll. of Science and Tech., London); McNab, I. R. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1679-84(Sept. 1968).

Experiments have been performed in the International Research and Development (IRD) Mk II helium–cesium MPD facility with simultaneously applied electric and magnetic fields. By increasing the total current density in the plasma from 2 to 440 ma/cm$^2$, the plasma impedance decreased by a factor of 100 owing to a nonequilibrium increase of the electron temperature and number density. Nonideal behavior in the form of a much reduced Hall potential was always present and is attributed mainly to nonuniformities in the plasma conductivity, probably as a result of inadequate mixing of the seed material with the buffer gas. Other mechanisms known to contribute to the lowering of the generator performance include wall and plasma-to-ground leakage and finite segmentation. Further evidence for the large nonequilibrium decrease of plasma resistance with current was the amplification and harmonic generation of small voltage fluctuations. (auth)

**45991** DISK GENERATOR. Louis, Jean F. (Avco Everett Research Lab., Everett, Mass.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1674-8(Sept. 1968).

The use of the disk generator as a practical device for power generation is discussed and compared to a linear device in terms of maximum allowable electric fields, magnetic field utilization, and surface-to-volume ratio. The swirl induced by the azimuthal force acting on the radial current is found to be of prime importance for the generator's performance. For certain values of the inlet swirl opposing the azimuthal Lorentz force, the output current becomes a conductive current as in a Faraday generator, and this results in increased efficiency for given Hall coefficients and loading. Examples and design concepts are discussed. (auth)

**45992** NONEQUILIBRIUM MHD-GENERATOR LOSSES DUE TO WALL AND INSULATOR BOUNDARY-LAYER LEAKAGES. Hoffman, Myron A. (Massachusetts Inst. of Tech., Cambridge). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1667-73(Sept. 1968).

The current leakages through the channel walls, ground-loop paths, and insulator-wall boundary layers are examined, and simplified analytical models are developed for nonequilibrium Faraday MHD generators. The results indicate that high insulator wall resistance and high insulator boundary-layer resistance are considerably more important for supersonic generators employing nonequilibrium ionization than for those employing equilibrium or frozen ionization. The high electrical resistance for these current leakage paths is required to keep the attainable nonequilibrium electron density high and the electron-density relaxation length short. The analytical models should prove useful to experimentalists, both as a guide in designing MHD-generator test sections and in the analysis and interpretation of experimental results. In particular, the models can be used to estimate the minimum acceptable channel dimensions, wall resistances, wall temperatures, and preionizer performance required for good test results. (auth)

**45993** EXPERIMENTAL ANALYSIS OF AN MPD CLOSED-CYCLE GENERATOR WITH QUASI-EQUILIBRIUM PLASMA. Bertolini, E.; Gasparotto, M.; Gay, P.; Hoffman, M. A.; Toschi, R. (Comitato Nazionale per L'Energia Nucleare, Frascati, Italy). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1658-66 (Sept. 1968).

The first series of MPD experiments performed with the Comitato Nazionale per L'Energia Nucleare (CNEN) closed-cycle facility is described. The entire facility, a blowdown loop capable of producing a high-purity noble gas, alkali-seeded plasma of 2-MW thermal power, has been thoroughly tested and has performed satisfactorily. The performance of a small-scale MPD generator with quasi-equilibrium plasma is shown to be influenced by ceramic leakage and plasma insulation from ground. Operating at Hall parameters up to three, the open-circuit Faraday field (29 v/cm) remains over 80% of its ideal value and the Hall field (28 v/cm) over 50% of its theoretical value, in which electrode voltage drop and segmentation effects are taken into account. The deviations of measured values from theoretical ones for both electric fields and conductivity are explained, at least qualitatively, by a simplified analytical model of wall and ground-loop (WGL) leakages. (auth)

**45994** MHD GENERATOR IN TWO-TERMINAL OPERATION. Wu, Y. C. L.; Dicks, J. B.; Denzel, D. L.; Witkowski, S.; Shanklin III, R. V.; Zitzow, U.; Chang, P.; Jett, E. S. (Univ. of Tennessee, Tullahoma). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1651-7(Sept. 1968).

Experimental results of a two-terminal connected, 60° diagonal conducting wall (DCW) generator and a Hall generator under identical channel entrance conditions are presented. The governing equations for two-terminal connected, MHD generators were derived under the assumption of homogeneous electrical properties

and with corrections, including the finite size of electrodes. A comparison of the outlined theory with the experimental results shows that other losses not included in the theory can be represented by a factor reducing the induced emf of the generator. (auth)

**45995** ELECTRICAL PERFORMANCE OF A DUCT WITH SEGMENTED ELECTRODES UNDER VARIOUS CONDITIONS. de Montardy, A.; Pericart, J. (Electricite de France, Paris). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1633-9(Sept. 1968).

An MHD duct with 56 electrode pairs has been tested on a 10-MW thermal test facility. The cross section of the generator is constant and rectangular, the distance between electrodes facing each other is 13 cm, and the length of the electrodes 7 cm. The insulating walls are of the peg-wall-type, and each electrode is made of 9 small zirconia praseodymium oxide bricks brazed in a copper holder. Between two zirconia pieces, a thin plate of platinum + 40% rhodium is able to collect the current from the hot and conducting parts of the ceramic. All the 112 electrodes are independent, and many load systems are possible. Measurements were made of the transverse open-circuit voltages; Hall generator operations; and series-connected generator with connection angle corresponding to $E_Y/E_X = -0.96$ (open-circuit and short-circuit operations for the last two). The results obtained show that a one-dimensional analysis has enough accuracy to predict the performance of this generator, but it is necessary to take into account the voltage drops at the electrodes, which are quite important despite the fact that the electrodes are hot (surface temperature ~2000°C). The main limitation of the duct was due to the insulators unable to withstand the voltages developed for a long time. Other interesting data obtained during the experiments are the currents collected at the end of the Hall and series-connected generators. It was possible to determine the percentage of the load current collected by the upper electrodes and the part by the lower ones. (auth)

**45996** EFFECTS OF ELECTRODE AND BOUNDARY-LAYER TEMPERATURES ON MHD-GENERATOR PERFORMANCE. Kessler, R.; Eustis, R. H. (Stanford Univ., Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1640-6(Sept. 1968).

Experiments were performed in a combustion-driven MHD generator to determine the effects of electrode temperature and boundary-layer temperature on its performance. The generator was a single electrode pair guarded to avoid end effects by two electrode pairs both upstream and downstream. However, end effects were found small, so the tests can be interpreted in terms of a five-electrode-pair generator. The electrodes were held at three temperature levels—775°, 1475°, and 1685°K—by controlling individual cooling circuits. Two electrode boundary-layer temperature profiles were investigated: one resulting from a hot (2400°K) upstream wall, and the other resulting from a cold (750°K) water-cooled plate that replaced the normal upstream electrode wall. Probes were installed in the insulator side wall between the center pair of electrodes to measure the voltage profile in the gas. Visual and photographic observations of the electrodes were made. It was found that the generator with hot electrodes downstream of the hot walls produced about seven times the power of the generator with cold electrodes downstream of cold walls. Electrode voltage drops, obtained from the side-wall probe data, were found to vary with load current, electrode temperature, and upstream wall temperature. Cathode voltage drops were higher than anode voltage drops, but the difference decreased with increasing electrode temperature and upstream wall temperature. An analytical model was postulated to interpret the data. The ohmic resistance of the boundary layer was calculated by integrating an equilibrium conductivity profile through the boundary layer to a point 1-Debye length from the electrode surface. The calculated values agree with resistance of the anode boundary layer obtained from probe data. The difference between resistances of cathode and anode boundary layers was attributed to surface and/or sheath effects at the cathode. (auth)

**45997** IONIZATION EQUILIBRIUM IN A PLASMA DIODE. Kosyrev, F. K.; Nastoyashchii, A. F. Zh. Tekh. Fiz., 38: 935-7(May 1968). (In Russian).

The ionization equilibrium in a plasma layer, maintained by an electric current (plasma diode, thermoemission converter, etc.) was investigated. It was shown that with establishment of the local ionization equilibrium in the plasma the spatial distributions of the plasma density and electron temperature must satisfy some simple laws, whose expressions were given. The laws were experimentaliy confirmed by spectroscopic measurements in cesium plasma. (tr-auth)

**45998** THE TRANSFER OF GENERATOR SEED MATERIAL AND HEAT FROM OUTLET GASES OF MHD GENERATORS TO INLET GASES THEREOF. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,110,326. Apr. 18, 1968. Priority date July 28, 1964, Germany.

A method of heating gas supplied to the MHD generator in an electricity generating plant is described. In this method a heat transfer medium is heated in a first region by direct contact with gaseous material as emerged from the generator channel and which includes generator seed material. The heated transfer medium is therefore transferred via a first pathway from the said first region to a second region where it is used to heat by direct contact the gas being supplied to the generator; and a further transfer medium is withdrawn from a seed material entrainment zone of the first region, in which zone the temperatures of the transfer medium is below the boiling point of the seed material. It is then transferred via a pathway separate from the first pathway to an evaporation zone through which the gas is being supplied to the generator. In this evaporation zone the temperature is above the boiling point so that the seed material is released from the further transfer medium. (M.H.R.)

**45999** EXPERIMENTAL INVESTIGATION OF FISSION FRAGMENT ELECTRONIC CHARGE LOSS. Linnerud, Harold Jacob. Stanford, Calif., Stanford Univ., 1967. 95p.

Thesis.

The Fission Electric Cell (FEC) is a direct-energy conversion concept which has been studied from both theoretical and experimental aspects. These studies have been hampered by lack of reliable information on fission-fragment behavior. Accurate descriptions of energy–range dependence, together with energy- and charge-loss models, are needed to extend both theoretical and experimental studies. A system was designed to measure the effective electronic charge of fission fragments. The main structural component was a six-inch-diameter aluminum tube, which was positioned in the thermal column of the Stanford Pool Reactor, and evacuated to ~$1 \times 10^{-4}$ mm Hg for measurements. The fragment emitter was a 10-mil stainless steel disc with a 2.31 mg/cm$^2$ coating of $UO_2$ (93% enriched). Fragments emitted in a small solid angle along the forward direction deposited their charge on a collector plate at the other end of the tube. Emitter–collector separation was 20 inches. A grid system was designed to control primary and secondary electron effects. The rate of charge deposition was determined with a sensitive dc electrometer. Permanent magnets were affixed to the rear of the emitter plate and background measurements were made by using external electromagnets to rotate the emitter by 180°. The fragment impingement rate was determined in a separate measurement by positioning a thin plastic film in front of the collector and allowing fragments to impinge on it. This film, after etching with NaOH, could then be viewed under a microscope and a direct count taken of fragment impingement holes. By rotating the emitter through known angles, measurements were made of fragment charge as a function of several effective $UO_2$ thicknesses. Several measurements were also made to study charge variation in Mylar, by covering the emitter with several layers of 0.5 mg/cm$^2$ Mylar. (TSS) (Diss. Abstr.)

# Fluid Physics

**46000** EVALUATING ION SLIP IN A SLIGHTLY IONIZED GAS MIXTURE. Abramov, Yu. N.; Zaitsev, V. N. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 4, 43-8(1967). (In Russian).

A brief literature survey is made on MHD problems dealing with the ion slip phenomenon, and several errors are pointed out that deal with the correct inclusion of the ion slip term in Ohm's law. For a slightly ionized, quasi-neutral plasma consisting of a mixture of neutrals (single kind only), electrons, and singly charged ions, an expression is derived for the ion slip. This expression is then incorporated in Ohm's law as $J = [1 + \mu_e B\mu_i B/(1 + \mu_e B\mu_i B)^2 + (\mu_e B)^2]\sigma E' - [\mu_e B/(1 + \mu_e B\mu_i B)^2 + (\mu_e B)^2]\sigma E' \times (B/B)$ where J is the current density, B the magnetic field, E the electric field, $\mu$ the mobility, $\sigma$ the electric conductivity, and the subscripts, e, i, n denote electrons, ions, and neutrals, respectively. For a given value of the Hall parameter, the ion slip contribution is calculated for He + K, He + Cs, Ne + K, Ne + Cs, Ar + K, and Ar + Cs plasmas. It is shown that the effect of ion slip on an MHD generator depends on the ion-to-neutral mass ratio and the ion-to-electron temperature ratio. For large molecular weight MHD generators, the ion slip effect is found to be negligible. (ATD)

**46001** MAGNETOHYDRODYNAMICS IN MICROSCALE. Wennersten, Dwight L. Res. Rev. (Office Aerosp. Res.), 7: No. 4, 16-17(Apr. 1968).

Laboratory simulations of MHD events are considered. Experiments on mercury lubricating films in thrust bearings are described, and some pressure profiles at various magnetic fields

are given. Bearing torques measured on an air bearing combined with an MHD thrust bearing are presented and the possibility of bearing performance control pointed out. (D.L.C.)

**46002** ON THE STABILITY OF PLANE POISEUILLE FLOW WITH A FINITE CONDUCTIVITY IN AN ALIGNED MAGNETIC FIELD. Ko, Sung-hwan (General Dynamics Corp., Rochester, N. Y.). J. Fluid Mech., 33: 433-43(Sept. 2, 1968).

A study is made of the stability of a viscous, incompressible fluid with a finite conductivity flowing between parallel planes in a parallel magnetic field. The general form of the magnetohydrodynamic stability equation is a sixth-order differential equation. The complete sixth-order differential equation is solved numerically as an eigenvalue problem. Stability curves are obtained for a range of values of the magnetic Reynolds number $R_m$ and the Alfvén number A based on two-dimensional disturbances. It is found that the minimum critical Reynolds number is raised as $R_m$ increases for a given $A^2$ and as $A^2$ increases for a given $R_m$, respectively. The stability curve closes and finally degenerates to a point which gives the critical value for $R_m$ or $A^2$. Results obtained for two-dimensional disturbances are modified to take into account three-dimensional disturbances. The minimum critical Reynolds number where three-dimensional disturbances become apparent is then obtained, below which two-dimensional disturbances are the most unstable. (auth) (UK)

**46003** A GENERAL THEORY OF THIN AIRFOILS IN NONEQUILIBRIUM MAGNETOGASDYNAMICS. PART I. ALIGNED MAGNETIC FIELD. Bhutani, Om Prakash; Nanda, Kul Deepak (Indian Inst. of Tech., New Delhi). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1757-62(Sept. 1968).

Green's function technique is extended to the development of a general theory of thin airfoils in nonequilibrium magnetogasdynamics. An exact solution for the velocity potential is obtained, and velocity at the airfoil surface is calculated for many significant cases. A critical study of the expressions for velocity at the surface, for various physical situations, leads to results that have no counterpart in the corresponding nonmagnetic study. In particular, it is shown that, in the nonequilibrium magnetogasdynamical case, only those types of flows are possible which if subsonic must be super-Alfvenic and if supersonic must be sub-Alfvenic. (auth)

**46004** SIMPLE WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Perrin, Henri (Institut de Mathematiques, Lille). Compt. Rend., Ser. A and B, 267: 53-6(July 1, 1968). (In French).

A study is made of a class of solutions that can generalize the motions of simple waves of classical mechanics. As in hydrodynamics, one finds that the fundamental system of equations with partial derivatives of relativistic magnetohydrodynamics reduces to an ordinary differential system. (tr-auth)

## Geophysics

*Refer also to abstracts 45368 and 45976.*

**46005** (AVSSD-0149-66-CR) ANTARCTIC RESEARCH AND DATA ANALYSIS. SCIENTIFIC REPORT 23. SOME GEOMAGNETIC AND IONOSPHERIC EFFECTS IN ANTARCTICA PRIOR TO STORM SUDDEN COMMENCEMENTS. Bowman, G. G. (Avco Corp., Wilmington, Mass. Avco Space Systems Div.). Aug. 11, 1966. Contract NSF-C-403. 34p.

Ionospheric height changes, blackout conditions, and geomagnetic activity for Antarctica in the relatively quiet times (geomagnetically) before storm sudden commencements are investigated. The principal results give evidence for 24-hourly periodicities in these parameters, and suggest that 24 hours before storm sudden commencements the occurrence of negative magnetic bays and auroral zone ionospheric height rises is enhanced. The implications of these and other relevant observations are discussed, and some ideas involving intense local dumping of low-energy outer-zone electrons at 24-hourly intervals are advanced. (auth)

**46006** (MATT-Trans-64) SIMULATION OF THE INTERACTION OF THE SOLAR WIND WITH THE EARTH'S MAGNETIC FIELD. Managadze, G. G.; Podgornyi, I. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow, Institut Atomnoi Energii). Translated for Princeton Univ., N. J. 19p. Dep. CFSTI.

The possibility of simulation of the interaction of the solar wind with the Earth's magnetic field is investigated. Exact simulation of all the processes in the magnetosphere turns out to be unrealizable in practice; however, it is possible to select the parameters of the experiment in such a way that the most interesting cosmic phenomena may be reproduced in the laboratory. Results of experiments with respect to formation of the neutral layer are presented as an example of the accuracy of limited simulation. (auth)

**46007** (N-68-23502) ALOUETTE PLASMA RESONANCE PHENOMENA. Tataronis, J. A.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). Apr. 1968. 36p. (NASA-CR-94548; SU-IPR-234). CFSTI.

It has been established theoretically that a magnetoplasma is capable of ringing at harmonics of the electron gyrofrequency and at the upper hybrid frequency. This resonance phenomenon arises theoretically from singularities of the plasma Green's function due to the pinching of the real wave-number axis by zeros of the dispersion relation describing the normal plasma modes. Typically, there are three values of the wave-number, $k_\perp$, where pinching occurs: first, at $k_\perp = 0$, second at $k_\perp = \pm\infty$, and third at special values where $0 < k_\perp < \infty$. The last type of ringing does not appear to have been observed either in the ionosphere or in the laboratory. In this paper, a numerical study is made of the three cases to determine the relative strengths of the corresponding ionospheric resonances, and hence to determine which resonances are to be expected in sounder experiments. (auth) (STAR)

**46008** (N-68-23597) DETERMINATION OF RATES OF PRODUCTION AND LOSS OF ELECTRONS IN THE F REGION OF THE IONOSPHERE FROM OBSERVATIONS OF GEOSTATIONARY SATELLITE TRANSMISSIONS. Smith III, Fred L. (Stanford Univ., Calif. Radioscience Lab.). Mar. 1968. 137p. (NASA-CR-94604; SEL-67-102; TR-10). CFSTI.

Accurate measurements of the amount of Faraday rotation imposed on vhf telemetry transmissions from a geostationary satellite were analyzed to study rates of production and loss of electrons in the F region of the ionosphere. The rate of photoionization of atomic oxygen, integrated with respect to height through the ionosphere, was determined at sunrise over Hawaii. The analysis also yielded the magnitude of the linear loss coefficient at an altitude of 300 km. The integrated rate of production of $O^+$ ions at sunrise was used to deduce the total flux of solar radiation in the 165- to 911-Å wavelength range incident on the Earth's atmosphere. Atomic oxygen photoionization rates and solar euv flux values were obtained on a daily basis, and loss coefficients on a monthly average basis, over the 2-year period extending from September 1964 through August 1966. (auth) (STAR)

**46009** (N-68-24733) SATELLITE OBSERVATIONS OF RADIO NOISE IN THE MAGNETOSPHERE. Bauer, S. J.; Stone, R. G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 11p. (NASA-TM-X-63216; X-615-68-185). CFSTI.

Noise bands at medium frequencies appear to originate from energetic-particle interactions with the thermal plasma. Their cutoffs are determined by magneto-ionic parameters of the medium and can be used to determine local plasma density. (auth) (STAR)

**46010** SOME PROPERTIES OF THE SLOWLY VARYING IONOSPHERIC ABSORPTION EVENTS IN THE AURORAL ZONE. Bewersdorff, A. (Max-Planck-Institut fuer Aeronomie, Harz, Ger.); Kremser, G.; Riedler, W.; Legrand, J. P. Ark. Geofys., 5: 115-27(1967).

Slowly varying ionospheric absorption events (SVA events) observed in Kiruna, Sweden were investigated with the aid of simultaneous balloon measurements of auroral x rays and riometer and magnetometer recordings of several stations around the auroral zone. The main results are: (1) all SVA events were accompanied by polar magnetic substorms; (2) the SVA events in Kiruna, Sweden started during breakup-type absorption on the nightside at Fort Churchill, Canada; (3) during SVA events x rays were observed—their energy spectrum flattens considerably in the course of each event; and (4) some observations indicate that the SVA events may partly be due to proton bombardment. It appears that the SVA events must be regarded as the local aspect of an extremely extended precipitation region. (auth)

**46011** LATITUDE VARIATION OF TIMES OF MAXIMUM h'F AND SPREAD F OCCURRENCES. Kumar, V. R. Jagath; Rao, B. Ramachandra (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 6: 319-21(June 1968).

The latitude variation of time of occurrence of $h'_{max.}F$ (the maximum value of h'F in the night time 1800–0600 hrs) was studied and compared with the latitude variation in the time of occurrence of maximum spread F probability reported by the authors [Indian J. Pure Appl. Phys., 3 (1965), 503]. A gradual variation is observed in the time of occurrence of $h'_{max.}F$ with geomagnetic latitude. During the sunspot maximum year, h'F reaches a maximum value in the pre-midnight period for geomagnetic latitude less than 20 to 40° and greater than 60 to 70°, the actual value varying from season to season. For other latitudes h'F reaches its maximum value in the

post-midnight period. For the sunspot minimum period, h' F reaches its maximum slightly before midnight for latitudes in the range of 50°N. to 50°S. and after midnight for higher latitudes. Comparing $h'_{max}$F curves and spread F peak occurrence curves for the maximum sunspot year it is concluded that for the same latitude, h' F peak occurs, in general, earlier than spread F peak, the delay varying with latitude and season. (auth)

**46012** STUDIES OF GIANT PULSATIONS, CONTINUOUS PULSATIONS, AND PULSATION TRAINS IN THE GEOMAGNETIC FIELD. Eleman, Folke. Ark. Geofys., 5: 231-82(1967).

The amplitudes, periods, polarizations, and geographical distributions of six giant pulsation (Pg) events in 1963 are discussed. It appears that the zone of oscillations remains rather fixed, geographically, during the lifetime of a Pg event, the amplitudes at different stations experiencing uniform intensity variations. The Pg areas have in general an east-west extension, roughly along the auroral zone. For the investigation of Pc, 34 events that occurred in the period February 1963–January 1964 were picked out. The criterion for their selection was that the pulsations were of a regular and sinusoidal type simultaneously at the five stations Kiruna, Enköping, Wingst, Göttingen, and Fürstenfeldbruck. Average amplitudes and periods were computed for the whole year. The data were also partitioned into various subgroups according to season, time of day, etc. The latitude dependence of the Pc square amplitudes has also been studied. It was found that the D amplitudes decrease monotonically from north to south. The investigation also includes some Pt events. It is shown that they, too, display a latitude dependence of periods and square amplitudes. The polarization of Pc and Pt in the H–D plane shows a rather constant pattern for the five stations, with a transition from clockwise to counterclockwise sense in south Sweden. (auth)

**46013** THE 2- TO 4-SECOND MICROPULSATION BAND AND MAGNETIC ACTIVITY. Kozlowski, Mieczyslaw (Univ., Warsaw). Acta Geophys. Pol., 16: 153-61(1968). (In Polish).

Micropulsations Pc1 + Pi1 which at Kiruna occurred around magnetic midday were followed in many cases (80%) by polar disturbances at College. The mutual dependence between the period of the micropulsation and intensity of the disturbances at auroral and equatorial zones was investigated. The tendency is observed, that the period of the micropulsation seems to be a function of the Dst (H) intensity. (auth)

**46014** PROSTRANSTVENNO-VREMENNOE RASPREDELENIE POLYARNYKH SIYANII. (Space-Time Distribution of Auroras). Khorosheva, O. V. Rezul'taty Issledovanii po Mezhdunarodnym Geofizicheskim Proektam, Polyarnye Siyaniya, No. 16. Moscow, Izdatel'stvo Nauka, 1967. 84p.

This book contains the results of studies of the space–time distribution of auroras on the basis of worldwide photographic observations conducted during and after the IGY period. The observations differ from any previously conducted, since they were synchronized to an accuracy of several seconds, thus allowing simultaneous worldwide results at any given instant. It has been determined that auroras occur simultaneously on both the night and day sides of the earth and are distributed in a ring pattern which is asymmetric relative to the geomagnetic pole. Due to the Earth's rotation, the auroral ring exhibits a regular diurnal drift relative to a surface point of observation, and this drift provides some explanation of the basic statistical regularities in auroral behavior. There is a close space–time relationship between the auroral ring and the boundary of captured 40-keV electrons beyond which sporadic currents of soft electrons are constantly observed. These soft electrons are a source of visual auroras. The nature of the two auroral zones (the Fritz zone and the inner zone) and of the polar spirals is defined. Particular attention is given to the relationships between auroras and ionospheric and geomagnetic disturbances, and between auroras and the radiation belts. (IAA)

**46015** MORPHOLOGY OF THE VISIBLE AURORA. Gustafsson, Georg (Kiruna Geophysical Observatory, Sweden). Acta Geophys. Pol., 16: 129-44(1968).

The investigation has been based on all sky camera and photometer measurements, and mainly recordings which have been made at Kiruna during the years of high sunspot activity. It has been found that the maximum auroral activity occurred in 1960 two years after the sunspot maximum. The latitude and time variations of the auroral zone are studied and it has been found that the north–south motion of the zone during the night amounts to 1.5 degrees of latitude on the average. The width of the "half intensity" zone was found to be about seven degrees. The diurnal variation of the aurora shows a maximum at geomagnetic midnight but it is not symmetric, the intensity is higher before midnight than after. A special technique has been described for evaluation of the intensity of the polar glow at an auroral zone station. The method has been applied to the night of November 12–13, 1960. (auth)

**46016** CHARACTERISTICS OF PROPAGATION OF ELF ELECTROMAGNETIC WAVES TO GREAT DISTANCES BELOW AN ANISOTROPIC IONOSPHERE. Yamashita, Michiko (Nagoya Univ., Toyokawa, Japan). Electron. Commun. Jap. (Engl. Transl.), 50: 75-82(May 1967).

Propagation characteristics of elf (extremely low frequency) electromagnetic waves were examined using a model of the ionosphere where the Earth is a perfect conductor and the terrestial magnetic field is superimposed thereupon. By comparing the results of observations made on slow tail atmospheric waveforms for this type of anisotropic model with the results for an isotropic model without the terrestial magnetic field, it was found that in the propagation of elf waves it is desirable to take into consideration the effects of the terrestial magnetic field. With respect to the refraction index of the ionosphere, the term for the terrestial magnetic field dominates the term for the number of collisions between electrons. It was assumed that elf waves can penetrate the ionosphere with relatively small attenuation and have a relatively high point of reflection. (BBB)

**46017** IONOSPHERIC RADIO COMMUNICATIONS. Proceedings of a NATO Institute, Finse, Norway, April 13–19, 1967. Folkestad, Kristen (ed.). New York, Plenum Press, 1968. 478p. (CONF-670449).

Separate abstracts were prepared for sixteen of the papers. (W.D.M.)

*For abstracts of individual papers see: 46018–46033.*

**46018** GENERAL PATTERN OF AURORAL PARTICLE PRECIPITATION AND ITS IMPLICATIONS FOR HIGH LATITUDE COMMUNICATION SYSTEMS. Hartz, T. R. (Defence Research Telecommunications Establishment, Ottawa). pp 9-32 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Ionospheric radio communications in the Arctic are known to suffer adverse effects during intervals when the auroral activity is high. This paper considers the aurorally associated disturbances of the upper atmosphere, and particularly the anomalous ionization, from a gross statistical point of view. The geographic regions in which the phenomena are most prevalent are indicated, and the latitudinal and diurnal variations of the various ionospheric parameters are summarized. Two dissimilar zones are identified, the characteristics of the particle precipitation in each are reviewed, and the importance of these zones for radio communications is discussed. (auth)

**46019** CHARACTERISTICS OF POLAR CAP ABSORPTION. Holt, Olav (Norwegian Defence Research Establishment, Kjeller. Auroral Observatory, Tromsoe, Norway). pp 33-45 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

The paper is a review of the knowledge of polar cap absorption. The time and space variations of PCA, mainly as they appear on riometer records, are described. The relation of PCA to solar activity, the propagation of solar cosmic rays through interplanetary space, and how they interact with the geomagnetic field and produce ionization in the Earth's atmosphere, are discussed. Finally, some comments on radio communication and PCA are made. (auth)

**46020** IONIZATION MAXIMUM IN POLAR LATITUDES. Power, Charles F.; Rush, Charles M. (Univ. of California, Los Angeles). pp 46-57 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Swept frequency sounders in satellites constitute excellent means for synoptic studies of the electron density distribution above the F2 peak. The essential part of the material in this presentation is based on data from Alouette I. It is concerned with the morphology and variability of a characteristic enhancement in the electron content observed at high latitudes. An attempt to relate the location and the structure of the enhancement region to solar–geomagnetic effects is described. Derived seasonal variations of the southern boundary and diurnal changes in the average position are given. (auth)

**46021** NORMAL AND ABNORMAL ABSORPTION AT HIGH LATITUDES. Piggott, W. R. (Radio and Space Research Station, Slough, Eng.). pp 58-62 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

The main features of absorption and absorption theory which

apply to problems of radio communications at high latitudes are summarized. The criterion for simplification is that any errors should be small compared with the variability of the total absorption. (auth)

**46022** COLLISION FREQUENCY IN THE HIGH LATITUDE D REGION. Thrane, E. V. (Norwegian Defence Research Establishment, Kjeller). pp 63-72 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Collision frequencies in the ionospheric D region are considered. A description is given of the methods which exist for studying the collision frequencies: laboratory investigations and radio-wave propagation experiments. It is shown that the results obtained by the two techniques are in satisfactory agreement. (auth)

**46023** ELECTRON DENSITY OBSERVATIONS DURING AURORAL ABSORPTION RELATED TO RADIO WAVE COMMUNICATION PROBLEMS. Jespersen, Mogens (Danish Space Research Inst., [Copenhagen]); Landmark, Bjoern. pp 73-80 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Results are given from propagation experiments for measurements of the density and collision frequency of the free electrons during conditions of auroral absorption. The results are discussed with emphasis on their importance for problems of radio wave communication at high latitudes. (auth)

**46024** PHYSICAL PROBLEMS OF PARTICULAR RELEVANCE TO ARCTIC COMMUNICATIONS. Meek, J. H. (Defence Research Telecommunications Establishment, Ottawa). pp 81-6 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

The complicated physical processes governing the polar ionosphere often interrupt high-latitude radio communications. For polar circuits presently used, prediction techniques are not adequate and need revision. Specific requirements and means for improving communications in the region concerned are discussed. It is stressed that the possibility for utilizing anomalous ionization structures, such as $E_s$ and the high-latitude trough, for sustaining propagation should be further exploited. There is need for a program to establish empirical prediction patterns by synoptic and morphological studies. (auth)

**46025** DISCUSSIONS OF VLF RECORDS OBTAINED DURING POLAR CAP ABSORPTION AND AURORAL DISTURBANCES. Egeland, Alv (Norwegian Inst. of Cosmic Physics, Oslo). pp 117-38 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

The influence of high-latitude disturbances on vlf propagation, based on measurements carried out at Spitzbergen from 1965 to 1967 is discussed. (W.D.M.)

**46026** SIMULTANEOUS VHF RIOMETER AND FORWARD-SCATTER OBSERVATIONS OF THE DISTURBED LOWER IONOSPHERE. Collins, C.; Maynard, L. A. (Defence Research Telecommunications Establishment, Ottawa). pp 155-64 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Continuous observations were made over a two-year period of the propagation modes of 41 and 104 MHz signals transmitted over a 1400-km circuit close to the auroral zone in northeastern Canada. A 30-MHz riometer located on one side of the path with a broad-beam antenna directed towards the mid-point of the forward-scatter circuit was used for continuous measurement of absorption on the path. Illumination of the common volume by the two systems thus provided simultaneous observations of the ionization changes in the lower ionosphere during magnetically disturbed periods. It was found that variations in the intensity of the signal propagated by the scattering regions near the path mid-point are strongly correlated over long periods with variations in the intensity of the cosmic noise as seen by the riometer. Temporal variations of the ratio of the median scatter-signal intensity to absorption over the two-year period provide qualitative information about the characteristics of the precipitating particle flux and the disturbed ionosphere below about 90 km. (auth)

**46027** METEOR BURST COMMUNICATIONS IN THE ARCTIC. Maynard, L. A. (Defence Research Telecommunications Establishment, Ottawa). pp 165-73 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Absorption and multipath propagation are important effects to be considered in operating meteor-burst systems at high latitudes. The greater part of this lecture is devoted to a description of multi-path modes as observed on two Canadian test circuits. Observed effects of an intense PCA event are discussed. (auth)

**46028** VHF BISTATIC AURORAL BACKSCATTER COMMUNICATION. Lange-Hesse, G. (Max-Planck-Inst. for Aeronomy, Lindau, Ger.). pp 174-205 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

A short review is given on the basic characteristics of the vhf-backscatter-phenomenon: Aspect sensitivity control by the geomagnetic field, back-scatter mechanism, and wavelength dependence. The geometry of the propagation path of vhf bistatic aurora backscatter communication is computed according to a theoretical model and compared with experimental observations. The computed curves in space along which the backscattering centers must be located (backscatter curves) coincide at least at one point with the simultaneous visual aurora display responsible for the observed backscatter communication. The computed maximum-possible-distance-curves for this kind of communication are in reasonably good agreement with the observations. Observed deviations from these curves at greater distances can be explained mainly by magnetic dip angle variations during geomagnetic storms. A short review about time variations (diurnal and seasonal) or bistatic auroral backscatter communication, as well as the control of the frequency of occurrence by the geomagnetic activity in different latitudes, is given. An explanation of some of the features of the auroral backscatter phenomenon is given using the new plasma acoustic-wave theory. (auth)

**46029** THE PROPAGATION OF HIGH FREQUENCY WAVES ON THE WINNIPEG–RESOLUTE BAY OBLIQUE SOUNDER CIRCUIT. Petrie, L. E.; Warren, E. S. (Defence Research Telecommunications Establishment, Ottawa). pp 242-59 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

The observed frequency limits for propagation of high frequency waves across the auroral zone between terminals at Winnipeg and Resolute Bay are presented. The accuracy of techniques for predicting the monthly median values of these limits, the effect of Spread F upon the F-layer junction frequency, and the nature of the mechanism determining the lowest observed frequencies of the propagation paths are discussed. (auth)

**46030** DEVELOPMENTS OF HF PREDICTIONS FOR THE ARCTIC. Petrie, L. E. (Defence Research Telecommunications Establishment, Ottawa). pp 263-71 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

A technique is described for predicting the F1-layer junction frequencies for latitudes greater than 35 °N. In addition, the calculation of more reliable factors for use in predicting the optimum traffic frequency is discussed and charts of these factors are presented. (auth)

**46031** RESULTS FROM STEPPED FREQUENCY OBLIQUE SOUNDINGS AT HIGH LATITUDES. Folkestad, K. (Norwegian Defence Research Establishment, Kjeller). pp 279-88 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Results from comparing measured maximum propagated frequencies with predictions on long-distance polar circuits are presented. Samples are given of circuit behavior during disturbed conditions. Detection of backscatter $E_s$ echoes is briefly discussed. (auth)

**46032** THE SIGNIFICANCE OF SPORADIC E PROPAGATION IN DETERMINING THE MUF. Stevens, E. E. (Defence Research Telecommunications Establishment, Ottawa). pp 289-93 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

Two aspects of sporadic E propagation are considered. One concerns the application of sporadic E tabulated data to propagation studies while the other refers to the significance of sporadic E propagation for paths in excess of 2000 km. (auth)

**46033** MORPHOLOGY OF FADING OF RADIO WAVES TRAVERSING THE AURORAL IONOSPHERE. Allen, Richard S. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 294-315 of Ionospheric Radio Communications. Folkestad, Kristen (ed.). New York, Plenum Press, 1968.

From Conference on Ionospheric Radio Communications, Finse, Norway. See CONF-670449.

The morphology of scintillation fading is developed for hf and vhf radio waves which have traversed the ionosphere at high latitudes. Forms are indicated for the variation of the depth of fading with sub-ionospheric latitude, geomagnetic conditions, seasonal and diurnal time, and solar cycle. Techniques are suggested for normalizing data obtained by different observatories with varying radio frequency or geometric parameters. Interdependence of several parameters indicates that a common cause controls the details of their behavior. (auth)

**46034** INSTABILITY OF ION-ACOUSTIC WAVES IN THE SOLAR WIND. Sudano, Jose Pantuso (Institut d'Astrophysique, Paris. Instituto Tecnologico de Aeronautica et Conselho Nacional de Pesquisas, Brazil). Compt. Rend., Ser. A and B, 267: 86-8(July 1, 1968). (In French).

The rate of growth or damping of ion–acoustic waves in the solar wind is studied. The solar wind model is that of Sturrock and Hartle, with two fluids of different temperatures. (tr-auth)

**46035** SIMPLE METHODS FOR CALCULATING LF AND VLF REFLECTION LOSS IN THE DISTURBED LOWER IONOSPHERE. Booker, Henry G.; Crain, Cullen M. (Rand Corp., Santa Monica, Calif.). Radio Sci., 3: 775-81(Aug. 1968).

Two simple methods for estimating lf and vlf reflection loss are devised, and the procedures for applying the methods are described. The first method involves estimating the actual height of reflection, fitting an exponential profile at this height, using the wave theory answer for the fitted exponential profile, and if necessary, applying a correction for departure from the fitted exponential profile well below the level of reflection. The second method integrates the nondeviating region attenuation coefficient up to a level chosen, using wave theory, to give the right answer when the profile near the level of reflection is exponential. For practical evaluations of lf and vlf transmission loss in nuclear burst environments involving highly oblique reflections in the lower D region, the methods presented can be applied with adequate accuracy for transmission frequencies at least as low as 10 kHz. (auth)

**46036** RAY-TRACING INVESTIGATION OF DIRECTION OF ARRIVAL OBSERVATIONS OF HF RADIO WAVES. Rao, N. Narayana (Univ. of Illinois, Urbana). Radio Sci., 3: 796-802(Aug. 1968).

A high-frequency radio direction-finding experiment involving a transmitter near Houston, Texas, and a receiver near Urbana, Illinois, has been under progress on a continuous basis for 1 week per month since March 1967. A network of five vertical incidence ionosondes located near and around the midpoint of the great circle path permit the evaluation of electron density gradients along the propagation path from true height analysis of ionograms recorded by this network. These gradients are used in conjunction with a three-dimensional ray-tracing computer program to compute the expected directions of arrival of the radio waves. Changes in bearing resulting from temporal variations in the electron density distribution and seasonal variations in the sunrise tilts are investigated. The results obtained by ray tracing are found to be in excellent agreement with the measured bearing deviations. Effective layer tilts are computed from the results of ray tracing. (auth)

**46037** OSNOVY PROGNOZIROVANIYA IONOSFERNO-MAGNITNYKH VOZMUSHCHENII I SLUZHBA KRATKOSROCHNYKH RADIOPROGNOZOV. (Principles of Predicting Ionospheric Magnetic Disturbances and the Short-Term Radio Forecasting Service). Zevakina, R. A.; Lavrova, E. V.; Lyakhova, L. N. Moscow, Izdatel'stvo Nauka, 1967. 80p.

This book describes the principles of short-term prediction of ionospheric geomagnetic disturbances and the operation of the Soviet short-term radio-propagation forecasting service. Newly discovered and previously known regularities of ionospheric disturbances are examined in terms of the characteristics of the disturbances and the deviations of the ionospheric parameters from the mean values. Conclusions are reached concerning the causes of various types of disturbances, and the resulting effects on radio communications are analyzed. The fundamentals of forecasting disturbances are investigated, and the types of short-term predictions issued by the Soviet forecasting service (IZMIRAN) are described. Instructions are given for the application of forecast data and current-conditions data in practical problems of radio communications. Examples of such problems include the determination of optimal operating frequencies for given conditions and forecast data. Explanations of Moscow and Irkutsk transmission codes are listed together with graphic material for calculating radio-propagation paths. (IAA)

**46038** PROPAGATION FACTORS IN SPACE COMMUNICATIONS. Blackband, W. T. (ed.). AGARD Conference Proceedings No. 3. Maidenhead, England, Technivision, 1967. 577p. (AGARD-CP-3).

The broad problems of space communications are dealt with — not just those of commercial space communications such as arise in the use of a satellite-borne microwave relay in a telephone or television link. Many papers discuss the effects upon propagation of irregularities in the electron distribution in the ionosphere. These papers fall into two groups, those that are based upon ground observation of satellite-borne transmitters, and those which recount the use of a topside sounder carried in a satellite. The possibility of using ionospheric prediction charts in order to forecast vlf signal intensity in satellite communications is discussed. Experimental work regarding effects of tropospheric turbulence at a wavelength of 3.2 mm is reviewed. A number of papers dealing with tropospheric propagation effects discuss the limit to the gain of large aerials which results from tropospheric turbulence. The effects of the troposphere extend in frequency beyond the radio spectrum and one chapter gives an account of laser beam propagation and the effects of turbulence upon it. (TSS)

**46039** HIGH FREQUENCY RADIO COMMUNICATIONS WITH EMPHASIS ON POLAR PROBLEMS. Lied, Finn (ed.). Maidenhead, England, Technivision, Nov. 1967. 139p. (AGARDograph-104).

The main purpose of this book is to provide simple up-to-date information on different problems which may arise in radio-wave communication, to give simple explanations for these and, when possible, point out how to circumnavigate these problems. The handbook is divided into four chapters. The first chapter deals with radio-wave communications under normal ionospheric conditions. Here the basic principles of radiowave propagation via the ionosphere are developed. The formation of the ionosphere, methods of studying it, and its normal variations are described. Having discussed the basic principles of ionospheric radio communications, the problem of predicting the future behavior of the ionosphere, both long term (months and years) and short term is tackled in Chapter 2. The final two chapters of the book are devoted to the problems of prediction and reduction of communication difficulties. Here the results of recent researches on the polar ionosphere are put into the context of communication problems. In particular, the properties of PCA events, auroral absorption, and high-latitude sporadic E are discussed in detail. (TSS)

## Low-Temperature Physics

*Refer also to abstracts 45028, 45230–45234, 45271, 45353, 45745, 46641, 46657, 46668, and 47037.*

**46040** (N-68-19140) AC LOSSES IN TYPE 2 SUPERCONDUCTORS. Di Salvo, Frank (Avco-Everett Research Lab., Everett, Mass.). Sept. 1966. Contract NAS8-5279. 49p. (NASA-CR-61654; AMP-206). CFSTI.

Two experiments were set up to determine the ac losses in Type-II superconductors, one using electrical methods and the other using calorimetric measurements. In the first experiment, alternating currents up to the quench current were applied to several feet of coiled Nb–Zr wire. The results, measured electrically, showed that: (1) the loss was directly proportional to the frequency; (2) at currents below 4 A rms, the loss is proportional to $I^2$; (3) at currents above 6 A rms, the loss is proportional to $I^{3.7}$; and (4) the magnitude of the loss depends sharply on the geometry of the wire configuration. The results lead to the conclusion that the magnetic field at the surface of the wire is the important variable in the determination of losses — not the transport current. In the second experiment, an ac magnetic field was applied to the superconductors (Nb–Zr, Nb–Ti, $Nb_3Sn$) and independently transport currents could be applied. The results, as measured calorimetrically, showed that, if the conductor is stabilized, the sample will carry currents to the short sample characteristic. As the transport current increases, the losses increase slightly. The loss due to the transport current is shown to be proportional to $I^2$. (auth)(STAR)

**46041** (UUIP-531) APPARATUS FOR MEASUREMENT OF THE DE HAAS-VAN ALPHEN EFFECT BY THE PULSED METHOD. Schwartz, H.; Bjoerck, G. (Uppsala Univ. (Sweden). Inst. of Physics). Apr. 1967. 23p. (In Swedish). Dep.

An apparatus is described for measurement of the de Haas–van Alphen effects. The apparatus makes use of the pulsed field method, and is used for investigations of the Fermi surface of metals and semiconductors. Results are given for measurement of antimony and antimony telluride ($Sb_2Te_3$). (Sweden)

**46042** A WAVE-RADIATION MODEL FOR THE ONSET OF DISSIPATION IN SUPERFLUID HELIUM AT THE ROTON CRITICAL VELOCITY. Takken, Edward Harold. Columbus, Ohio, Ohio State Univ., 1967. 175p.

Thesis.

A wave radiation model is proposed for understanding the onset of dissipation at the roton critical velocity in superfluid helium. This is a classical, correspondence-principle-limit point of view and is quite analogous to the classical description that is widely accepted for understanding the emission of photons by an electric charge that moves at a constant velocity greater than the speed of light in a dielectric medium. After first deriving a theory for the wave excitations and boundary-value problems of the correspondence principle limit for a condensed-boson system, this paper shows that a wave radiation field forms around a foreign body moving through the superfluid medium when the foreign body moves faster than the minimum phase velocity, $(\omega/k)_{min}$, of wave excitations in the medium. Moreover, the spatial dependence of this wave field and the loss of energy radiating through it are calculated as functions of the fractional increase of the foreign body's velocity above the threshold velocity $(\omega/k)_{min}$. In spite of approximations made in the calculations, the results indicate that it is impossible, experimentally, to force an ion complex to move through the superfluid component of helium at a velocity observably greater than the roton critical velocity. (Diss. Abstr.)

**46043** OSMOTIC PRESSURE OF DILUTE SOLUTIONS OF $^3$He IN $^4$He. Wilson, Mark Ferlin. Columbus, Ohio, Ohio State Univ., 1967. 138p.

Thesis.

Measurements of the osmotic pressure have been made between 0.32 and 1.8°K in solutions with less than 2% $^3$He concentration. The osmotic pressure is defined in terms of the chemical potentials of pure $^4$He and the $^4$He component of the solution as follows: $\mu_4(p,T,X) = \mu_4(p-\pi,T,O)$, where the pressure in the solution is p, X is the $^3$He concentration of the solution, and $\pi$ is the osmotic pressure. The range in concentration X was limited by the tensile strength of the pure $^4$He liquid. As the concentration and therefore the osmotic pressure increased, the stress in the pure $^4$He increased until its tensile strength was exceeded. The liquid then ruptured, leaving a liquid–vapor surface in the $^4$He chamber. The maximum observed tensile strength was 27 mm Hg at 0.66°K. The tensile strength appears to have a minimum value, above which the probability of rupture increases with the negative pressure. The data indicate small deviations from van't Hoff's law for ideal dilute solutions. This law may be expressed as $\pi v_4^0/XRT = 1$, where $v_4^0$ is the molar volume of pure $^4$He at temperature T, and R is the gas constant. The experimental values of $\pi v_4^0/XRT$ for solutions of 1% $^3$He concentration were 0.98 at 1.16°K, 1 at 0.65°K, and 1.04 at 0.32°K. The data at 0.32° and 0.65°K have been successfully correlated with a thermodynamic model of the solution. In this model, the molar entropy of the solution is represented by $S = XS_f + (1-X)S_4^0$. Here, $S_f$ is the entropy of a Fermi gas with a particle density equal to that of the $^3$He in solution, and with an effective mass $m^* = 2.34\ m_3(1+X)$ where $m_3$ is the atomic mass of $^3$He and X is the $^3$He concentration; $S_4^0$ is the molar entropy of the pure $^4$He. The data were found to be in poor agreement with the theoretical predictions of C. Ebner and Bardeen, Baym and Pines, and suggest that the current theory of the $^3$He quasiparticle interaction might be modified to include spin and velocity dependence. (TSS) (Disser. Abstr.)

**46044** THE PHASE SEPARATION CURVE AND MOLAR DENSITY OF DILUTE $^3$He–$^4$He MIXTURES. Ifft, Edward Milton. Columbus, Ohio, Ohio State Univ., 1967. 135p.

Thesis.

The phase-separation curve and molar density at saturated vapor pressure have been measured for seven different dilute solutions of $^3$He in $^4$He. The solutions, varying in concentration from 3.92 to 15.38%, were studied in the temperature range 0.024° to 1.25°K. Two different types of experiments were carried out: (i) to determine molar volume as a function of concentration, successive amounts of $^3$He were added to pure $^4$He in the cell at a constant temperature of 0.69°K, changing X from zero to about 0.15; (ii) to measure the phase-separation curve and thermal expansion, the temperature was reduced to 0.02°K and then increased in steps to 1.25°K using a constant amount of mixture. In the phase-separation region, all the molar-volume results lie on one curve, which gives the molar volume of the lower phase. In the single-phase region, there is a pronounced thermal contraction approximately proportional to X and T. The uncertainty in the data is about ±0.002 cm$^3$/mole except above 0.7°K, where a small additional uncertainty develops due to evaporation and refluxing effects in the filling tube. Assuming that the molar entropy of a solution is given by $S = XS_F + S_4$ where $S_4$ is the entropy of pure $^4$He and $S_F$ is the entropy of one mole of an ideal Fermi gas of the same number density as the solution, an expression for the change in molar volume with temperature was derived. With the aid of this equation, the molar volume at 0°K was found to be given by $v(X,O) = v_4(O)[1 + X\alpha(X,O)]$ where $\alpha_0 = 0.284 \pm 0.005$. The data also gave a value for the pressure dependence of the reduced mass of the $^3$He quasiparticles of $(\partial m^*/\partial P)_T = [(0.038 \pm 0.004) + (0.018 \pm 0.01)X]m_3$/atm at the saturated vapor pressure. Converting v(X,T) into X(T) gave the solubility curve in the lower phase. Below 0.15°K, this curve was found to fit the empirical equation $X = X_0[1 + 10.8(°K)^{-2}T^2]$ where the solubility, $X_0$, at 0°K is (6.37 ± 0.05)%. Fitting the data to the calculations of Ebner showed the binding energy for one $^3$He atom at 0°K, $E_0$, to be given by $E_0/R = (L_2^0/R) + (0.284 \pm 0.007)$ deg K where $L_2^0$ is the latent heat of pure $^3$He at 0°K, $L_2^0/R = (2.47 \pm 0.01)$ deg. K. (TSS)

**46045** ION TRAPPING IN ROTATING SUPERFLUID LIQUID HELIUM UNDER PRESSURE. Pratt, William Porter Jr. Minneapolis, Univ. of Minnesota, 1967. 156p.

Thesis.

Measurements of the lifetime of negative ions trapped in rotating superfluid liquid helium have been made in the range 10 to 1000 seconds as a function of temperature and applied electric field at the saturated vapor pressure of the liquid. Measurements of the lifetime of trapped negative ions have also been made in the range 20 to 400 seconds as a function of temperature and pressure from the vaporization pressure to the solidification pressure of liquid helium. The experiment involves observing the amount of trapped charge released by the liquid upon cessation of rotation. The data are interpreted in terms of models recently proposed in the literature for ion-trapping in the rotating liquid. There are two models involved: First, the negative ion is assumed to be an electron contained in a hollow cavity in the liquid of approximately 20 Å radius. Second, the rotating liquid is thought to consist of a uniform array of singly quantized vortices. The ions are assumed to be trapped by hydrodynamic forces on these vortex lines in the rotating liquid and to escape from these vortex lines by thermal activation. The activation energy for escape of an ion from a vortex line can be determined from the temperature dependence of the lifetime of the trapped ion. The radius of the ion can in turn be determined from this activation energy. At saturated vapor pressure such analysis of the data indicates that the radius of the negative ion is between 18.9 and 20.6 Å. As the pressure is raised from saturated vapor pressure to 24 atm, the radius of the negative ion decreases by 38%. This decrease compares favorably with the prediction of a simple form of the "bubble model" that the radius of the negative ion decreases by 35% over the same pressure range. The dependence of the lifetime of the trapped negative ion upon the applied electric field can also be understood in terms of these models. In addition, studies have been made in which trapped ions are used to probe certain properties of the rotating state of the liquid. Such studies include observations of the growth and decay of vorticity in the superfluid brought about by the starting and stopping of rotation of the vessel containing the liquid helium. Over the full range of pressures and temperatures covered, no positive-ion trapping was observed. (Diss. Abstr.) (TSS)

**46046** DENSITY INCREASE OF TURBULENTLY FLOWING He II. Erben, K. D.; Pobell, F. (Technische Hochschule, Munich). Z. Phys., 215: 103-12(1968).

A density increase of He II up to $\Delta\rho/\rho = 3 \times 10^{-4}$ due to turbulent flow caused by a heat current in a wide tube has been observed by pycnometric measurements and by measuring the dielectric constant of He II. The state of increased density appears to be metastable against mechanical disturbances. (auth)

**46047** RESISTIVITY OF A SUPERCONDUCTOR IN ITS NORMAL STATE. Schmid, Albert (Univ., Karlsruhe, Ger.). Z. Phys., 215: 210-12(1968).

Observations that the conductivity of a metal increases as the temperature is lowered toward the transition temperature to the superconducting state are explained on the basis of the Ginzburg–Landau equations and their time-dependent generalization. (A.G.W.)

**46048** CRITICAL MAGNETIC FIELD OF THIN SUPERCONDUCTING FILMS. Usadel, Klaus-Dieter (Univ., Goettingen, Ger.). Z. Phys., 215: 77-90(1968). (In German).

Thin superconducting films in a surface-parallel magnetic field are considered, assuming that the order parameter is constant in space. Without any further restrictions on the film thickness, a,

an equation for the critical field is derived. In a clean limit, this equation is valid only in the vicinity of $T_c$, but in the dirty limit it is valid for all temperatures. The results, for specular reflection, are identical with those obtained by Thompson and Baratoff. For not-too-thin films essential differences are found between the results for specular and for diffuse reflection. For very thin films ($a \ll v/2\pi T_c$), considered in detail by De Gennes and Tinkham and by Shapoval, the results are in agreement with those obtained by Shapoval. In the opposite limit ($a \gg v/2\pi T_c$), the most essential corrections to the Ginzburg–Landau result obtained by Lüders are rederived. (auth)

**46049** WAVE MODES IN LIQUID HELIUM CAPILLARIES. Meinhold-Heerlein, L. (Univ., Mainz). Z. Phys., 213: 152-70 (1968). (In German).

In liquid helium two wave modes are possible. Their properties may be analyzed by solving the thermohydrodynamical equations under the condition that the tangential component of the normal fluid velocity is vanishing on the walls. In the present paper these two types of wave propagation are determined for a plane-parallel capillary with the heat conduction and the thermal expansion being neglected and with the width of the capillary being much smaller than the penetration depth of a viscous wave. In particular, the dispersion relations of both the so-called fourth sound and an overdamped mode are calculated. (This overdamped mode may be called fifth wave mode.) The velocity fields can be determined, too, as well as the pressure fields and the temperature fields. It is shown that pressure and temperature are coupled in both cases. (auth)

**46050** SPATIAL DISTRIBUTION OF MAGNETIC FIELDS AND THE CRITICAL CURRENT DENSITY IN SUPERCONDUCTING LEAD–BISMUTH ALLOYS. Voigt, Hans (Siemens AG, Erlangen, Ger.). Z. Phys., 213: 119-51(1968). (In German).

Measurements of the spatial distribution of magnetic fields within superconductors were made with alloys of lead–bismuth, which allow for a large variation of superconducting properties. From these measurements critical current densities were derived as function of local magnetic field, and qualitative informations about surface currents are obtained. Field dependence of critical current density was calculated, using the method of Friedel (1963), which makes a characteristic shape to be expected at low fields. This shape was found experimentally. A semi-empirical extension of the relation given by Kim et al. (1962) and Anderson (1962) is proposed, which satisfactorily describes the measured current densities in the whole field range. (auth)

**46051** NOTE ON THE SUPERCONDUCTING DILUTE ALLOY WITH PARAMAGNETIC IMPURITIES. I. BASIC FORMULATION AND SOME APPLICATION. Kawamura, Kiyoshi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 39: 1375-1401(June 1968).

Superconducting dilute alloys with paramagnetic impurities are considered with the method of thermal Green functions. The self-energy part of electron Green functions is expressed in terms of Green functions of spin operators. The formulation established in this paper is so useful that spin operators can be dealt with dynamically. As an example, the effect of localized spins on the jump of the specific heat at the transition point and the order parameter at 0°K, as well as the known expression for the decrease of transition point are derived to the order of $J^3$. (auth)

**46052** FILAMENTARY SUPERCONDUCTIVITY IN α-URANIUM: THE IMPURITY EFFECT. Fisher, E. S. (Argonne National Lab., Ill.); Geballe, T. H.; Schreyer, J. M. J. Appl. Phys., 39: 4478-9(Aug. 1968).

The experiments were carried out to determine whether the impurities in the uranium samples used in various studies could be an important factor in determining $T_c$ and the critical magnetic fields for destroying the superconducting signal. The uranium sample used was a disk cut from an 11-g rod that was removed from the center of an 8-in. long zone-refined rod. Spark source mass spectrometer analyses of sections cut from both ends of the 11-g rod are shown. Results obtained from the magnetic response of the small sample, using the Schawlow–Devlin resonance-frequency method at 16 kHz are shown. These results show that the superconducting transition temperature in very pure uranium is more sensitive to the presence of deformation defects than uranium containing 80 to 100 ppM impurities. (M.H.R.)

**46053** MICROWAVE SURFACE RESISTANCE OF SUPERCONDUCTING NIOBIUM. Turneaure, J. P. (Stanford Univ., Calif.); Weissman, Ira. J. Appl. Phys., 39: 4417-27(Aug. 1968).

The unloaded Q's of pure Nb cavities in the $TE_{011}$ mode at 11.2 GHz and in the $TM_{010}$ mode at 8.4 GHz were measured between 1.2 and 4.2°K to determine whether the residual surface losses in Nb could be made sufficiently low to make it a useful material for practical microwave devices. Three forms of reactor grade Nb were evaluated: recrystallized fully wrought, arc melted, and electron-beam melted. Each of these materials was subjected to additional metallurgical processing including high-temperature vacuum firing and polishing to determine their effects on surface losses. In the $TE_{011}$ mode, a residual Q of $3.8 \times 10^{10}$ was achieved. Also in the $TE_{011}$ mode, the unloaded Q was observed to be essentially a constant up to the ac critical magnetic field $H_c^{ac}$, where it abruptly decreased by a factor of 100 or more. An $H_c^{ac}$ as large as 436 Oe was observed for unstrained Nb. In the $TM_{010}$ mode, which has electric fields terminating on the surface of the Nb, a residual Q of $2 \times 10^9$ was achieved, the limitation on the maximum field level in the cavity was $H_c^{ac}$, and no power loss associated with electric-field emission was observed up to an electric field of $2.1 \times 10^5$ V/cm, which was the maximum field level obtained in the cavity. The Mattis and Bardeen theoretical expression for the superconducting surface resistance fits the data very well, and the value of the energy gap $2\Delta(0)$ obtained from the fitting procedure is $(3.72 \pm 0.01)\ k_B T_c$, which agrees with values of $2\Delta(0)$ obtained by other methods. The surface resistance data are not inconsistent with a double energy-gap model, which has been used to explain specific heat data; however, it was not possible using the data to distinguish between a double energy-gap model and a single energy-gap model with a residual surface resistance. It would be expected that $H_c^{ac}$ would be about $H_{c1}$ where magnetic flux starts penetrating a type-II superconductor; however, the largest measured $H_c^{ac}$ (436 Oe) was in fact about $H_{c1}/4$. (auth)

**46054** FLUX-LINE ARRANGEMENT IN SUPERCONDUCTORS AS REVEALED BY DIRECT OBSERVATION. Traeuble, Hermann; Essmann, Uwe (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). J. Appl. Phys., 39: 4052-9(Aug. 1968).

The flux-line lattice in a type-II superconductor in the remanent state is investigated by means of a decoration method. The triangular lattice contains various kinds of defects, the most important of which are flux-line dislocations. A critical lattice parameter $d_c$ exists such that for lattice parameters $d > d_c$ the flux lines form no longer a lattice but a "flux-line fluid." A belt directly underneath the specimen surface is free from flux lines. The transition from the "fluid" to the flux-free region has been utilized to estimate in a fairly direct way the pinning forces acting on the flux lines. (auth)

**46055** CONTINUOUS FLOW CRYOSTAT FOR NEUTRON SCATTERING EXPERIMENTS. Koenig, U. (Technische Hochschule, Darmstadt, Ger.); Tippe, A.; Dalluegge, W. Kerntechnik, 10: 371-4(July 1968). (In German and English).

A continuous flow cryostat for neutron scattering experiments is described which allows the setting of any temperature between 4.2°K and room temperature. It has the advantage of short adjustment times for any temperature, and is, therefore, particularly suitable for experiments on the temperature-dependent magnetic scattering of neutrons in transition-metal compounds. Using this cryostat, the Néel temperature of $MnSeO_4$ was found to be $(28 \pm 1)$°K. (auth)

**46056** PROPOSED SUPERCONDUCTING THIN-FILM TUNNELING JUNCTION WITH NEGATIVE RESISTANCE ABOVE TEMPERATURES OF BOILING HELIUM. Blume, Hans-Jurgen C. (Langley Research Center, Hampton, Va.); Johnson, Preston B. Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 1395-6(Aug. 1968).

Superconducting thin-film tunneling junctions composed of Ta/$Ta_2O_5$/Nb and Nb/$Nb_2O_5$/V layers are proposed for application as negative resistance devices. The theoretical I–V curves of these junctions are presented, and the operating temperatures for optimum negative resistance characteristics are predicted to be about 4.4 and 5.1°K. (auth)

**46057** ISOTOPIC PHASE SEPARATION IN SOLID $^3$He–$^4$He MIXTURES. Panczyk, M. F.; Scribner, R. A.; Gonano, J. R.; Adams, E. D. (Univ. of Florida, Gainesville). Phys. Rev. Lett., 21: 594-7(Aug. 26, 1968).

The excess pressure due to phase separation of solid $^3$He–$^4$He mixtures held at constant volume has been measured. From this the phase-separation temperature was obtained as a function of the mole fraction, the excess volume, and the pressure dependence of the critical temperature. (auth)

**46058** LOCALIZED SPIN FLUCTUATIONS AND SUPERCONDUCTIVITY IN Ir-BASED DILUTE ALLOYS. Morandi, G. (Imperial Coll. of Science and Tech., London). Solid State Commun., 6: 561-4(Aug. 1968).

The behavior of $T_c$ as a function of impurity concentration was studied in Ir-based dilute alloys containing strongly exchange-enhanced nonmagnetic impurities. The effect of impurities is to cause a rapid decrease of $T_c$ until superconductivity is suppressed at a critical concentration which is about half the concentration leading to the magnetic instability of the model. (auth) (UK)

**46059** PROBLEM OF HIGH-TEMPERATURE SUPERCONDUCTIVITY. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Contemp. Phys., 9: 355-74(July 1968).

The critical temperature, $T_c$, for all presently known superconductors does not exceed 20°K. This fact obviously limits the range of applications of superconductivity in technology in a very fundamental way. The reason why the value of $T_c$ for 'ordinary' superconductors should not exceed 20 to 40°K is fairly well understood on the basis of the existing theory of superconductivity. High temperature superconductors for which the temperature $T_c$ would reach hundreds of degrees, or at least liquid air temperature could, however, apparently exist. Possible means of producing high temperature superconductors are considered. Special attention is paid to what can be called the exciton mechanism of superconductivity. (UK)

**46060** X-RAY STUDY OF THE PHASE TRANSITION IN $Nb_3Sn$. Medvedev, S. A.; Kiseleva, K. V.; Mikhailov, V. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 10: 584-6(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 746-9(Mar. 1968).

An x-ray study of the structure of polycrystalline stoichiometric $Nb_3Sn$ has been carried out by means of a high-resolution method (point focus x-ray tube and calculation of the diffraction lines by points). The (520) and (440) lines have been investigated by this method at 300, 15.5, and 10.5°K. At 300°K the structure of $Nb_3Sn$ was cubic, and the lines had the true shape of a well-resolved doublet. At 15.5 and 10.5°K both lines were considerably deformed. The operation of resolving the deformed lines (520) and (440) and the analysis of the conditions satisfying the simultaneous resolution of the two lines showed that the structure of $Nb_3Sn$ at 15.5 and 10.5°K (i.e., in the superconducting region) is tetragonal with a ratio of the unit cell edges $a/c = 1.0042 \pm 0.0007$. The structural transformation from the cubic to the tetragonal system takes place by compression of the original cubic cell along a four-fold axis (cube edge). (auth)

**46061** SPIN–LATTICE RELAXATION IN $M_3X$ SUPERCONDUCTING COMPOUNDS WITH TWO OVERLAPPING ENERGY BANDS. Fal'ko, I. I.; Serdyuk, A. D. (Gor'kii State Univ., Krakow). Sov. Phys.-Solid State (Engl. Transl.), 10: 541-3 (Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 688-92(Mar. 1968).

The temperature dependence of the spin–lattice relaxation time $T_1$ is examined in superconducting materials having two types of nuclei and two overlapping electron energy bands. A relationship is obtained between $T_1$ and the system of energy levels of each type of nucleus, the characteristics of the Fermi surface of each overlapping energy band, and the magnitude of the gap in each of them. The effectiveness of using the nuclear magnetic resonance method to study multigap superconductors is indicated. (auth)

**46062** USE OF PERTURBED ANGULAR CORRELATIONS IN THE STUDY OF THE INTERNAL MAGNETIC FIELD DISTRIBUTION IN TYPE-II SUPERCONDUCTORS. Alonso, J.; Grodzins, L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 549-56 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The intermediate-state magnetic field distribution in superconducting niobium was studied by means of the time-dependent perturbed angular correlation of the $\gamma$-$\gamma$ cascade in $^{100}Rh$. Samples were prepared by diffusing the 4-day $^{100}Pd$ parent uniformly throughout a niobium foil. Measurements at 4.2°K are in excellent agreement with the predictions of the Abrikosov theory of quantized flux vortices arranged periodically throughout the sample. (auth)

**46063** DETECTION METHOD FOR THE NORMAL-TO-SUPERCONDUCTING PHASE TRANSITION OF 10 $\mu$ SPHERES. McLachlan, D. S.; Feder, J. (IBM Research Lab., Zurich). Rev. Sci. Instrum., 39: 1340-2(Sept. 1968).

In order to study the superheating and supercooling in type-I superconducting spheres, with diameters of the order of 10 $\mu$, a low noise ($10^{-11}$ V) mutual inductance system has been developed capable of detecting the phase transition of less than $10^{-9}$ cc of a type-I superconductor. (auth)

**46064** SUPERCONDUCTIVITY OF PHOSPHORUS AT HIGH PRESSURES. Berman, I. V.; Brandt, N. B. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 7: 323-6(June 5, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 412-16(June 5, 1968).

The superconductivity of P was investigated in the pressure region 170 to 260 kbar. Both red and black phosphorus was used, and the destruction of the superconductivity of magnetic fields was studied. It is concluded that phosphorus has two or more superconducting modifications with $T_c = 5.8$°K and $(\delta H_c/\delta T)T_c = 1.2$ kOe/deg at 170 kbar. At higher pressures, a mixture of two or three superconducting modifications exists, with larger $\delta H_c/\delta T$ values. (D.L.C.)

**46065** KONDO EFFECT AND SUPERCONDUCTIVITY. Volkenshtein, N. V.; Startsev, V. E. (Inst. of Metal Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 7: 334-7(June 5, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 426-7(June 5, 1968).

The possible coexistence of superconductivity and the Kondo effect would result in a minimum in the electric resistance–temperature curve. Such a minimum was found at ~1°K in the electric resistance of Mo single crystals with very low Fe impurity content ($\sim 2 \times 10^{-4}$%), which was measured at 0.38 to 2.3°K. (D.L.C.)

**46066** SOME FEATURES OF THE TEMPERATURE DEPENDENCE OF THE SPECIFIC HEAT OF A NIOBIUM–TITANIUM ALLOY AT THE TRANSITION TO THE SUPERCONDUCTING STATE. Sukharevskii, B. Ya.; Alapina, A. V.; Dushechkin, Yu. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 54: 1675-9(June 1968). (In Russian).

The specific heat of a superconductor of the second kind ($Nb_{0,25}/Ti_{0,75}$ alloy) is measured between 4.2 and 17°K. It is suggested that smearing of the superconducting transition is due to its inhomogeneity. A method for treating the experimental data is proposed. The method permits one to determine the transition interval to the superconducting state and also the temperature dependence of the superconducting phase concentration in this interval and the coefficients in formula (3) of the BCS theory for the electronic heat capacity of an homogeneous superconductor near $T_c$. (auth)

**46067** EFFECT OF IMPURITIES ON THE SUPERCONDUCTING TRANSITION TEMPERATURE IN THALLIUM. Ignateva, T. A.; Makarov, V. I.; Tereshina, N. S. (Inst of Physics and Technology, Kiev). Zh. Eksp. Teor. Fiz., 54: 1617-25(June 1968). (In Russian).

Binary and ternary solid solutions of Tl containing Bi, Sb, In, and Hg are studied. It is found that the quantity $dT_K/dP$ as a function of the impurity concentration has a maximum. Such a dependence signifies that the topology of the Fermi surface changes under the influence of the impurity. (auth)

**46068** SUPERCONDUCTIVITY. De Gennes, P. G. (Faculte des Sciences, Orsay, France). pp 245-99 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

Six lectures are presented covering the following topics: (1) Bose condensation and superfluid properties; (2) quantum and Mercerean interferometers; (3) Landau–Ginzburg equations; (4) normal-superconducting interfaces, motion of flux tubes in type I materials, Eulerian argument for the clean limit, supercooling in type I superconductors, and calculation of nucleation fields; (5) supercooling of type I, dynamical experiment (Faber), superheating of type I, and type II materials; and (6) experiments on the vortex structure and electronic excitations near a vortex. (D.L.C.)

**46069** DIRECT ACCESS $^3He$ CRYOSTAT. Halpern, T.; Fritzsche, H. (Univ. of Chicago). Rev. Sci. Instrum., 39: 1336-9(Sept. 1968).

Details of the design and construction of a $^3He$ cryostat in which the experimental chamber can be reached directly from the outside are described. Main features of the system are the use of a copper-to-copper conical joint to lock thermally at 1.2 K the structural and electrical parts that will reach the low temperature experimental chamber, and the use of epoxied joints that can be easily opened to allow for the use of different geometries. This avoids the magnetic flux trapping associated with the presence of superconductive solder in the low temperature region. The refrigerator is capable of operating down to 0.32 K for at least 10 h as a one shot system and to 0.41 K with continuous circulation of the $^3He$. (auth)

**46070** THEORY OF DILUTE SOLUTIONS OF LIQUID $^3He$ IN $^4He$ AT LOW TEMPERATURES. Ebner, Charles Arthur. Urbana, Ill., Univ. of Illinois, 1967. 130p.

Thesis.

Various properties of dilute solutions of $^3He$ in $^4He$ at temperatures below about 1°K are calculated by viewing the solutions as comprised of interacting $^3He$ quasi-particles and phonons. The interaction between the quasi-particles is determined phenomenologically by analyzing measurements of the spin diffusion coefficient of solutions of 5.0 and 1.32% $^3He$ concentration; the quasi-

particle–phonon interaction, on the other hand, is found from first-principle arguments. The effective mass of the $^3$He quasi-particles, the spin susceptibility, the osmotic pressure, the specific heat, the $^3$He chemical potential, and the phase-separation temperature are all determined for solutions of various concentrations by doing perturbation theory with the quasi-particle interaction. The coefficient of thermal conductivity is calculated for 1.32 and 5.0% solutions at temperatures below 0.6 K, in which region it is completely determined by $^3$He–$^3$He scattering and $^3$He–phonon scattering. Where possible, comparisons with experiment are performed; agreement is generally good; an exception is the thermal conduction at temperatures well below the Fermi temperature of the $^3$He component of the system. An improvement in the solution of the $^3$He Boltzmann equation for this case is suggested. (Diss. Abstr.)

**46071** ANISOTROPY EFFECTS IN THE CRITICAL FIELD OF SUPERCONDUCTING TIN–INDIUM ALLOYS. Montgomery, David Carey. Urbana, Ill., Univ. of Illinois, 1967. 98p.

Thesis.

Measurements have been made of the critical-field curve, $H_c$ versus T, for eight superconducting dilute alloys of indium in tin near the critical temperature and at low temperatures extending to about 0.3°K. The effective magnitude of the superconducting energy gap is sensitive to the direction of the electron momentum relative to the crystal lattice—the so-called anisotropy effect. The reduction in electron mean free path that occurs upon addition of indium to pure tin reduces the effect of anisotropy in the electron–electron interaction. The decrease in the effect of anisotropy has been observed to depress the critical temperature $T_c$, the 0°K critical field $H_0$, and the constant $K = 2\pi\gamma T_c^2/(VH_0^2)$. In terms of the reduced critical-field curve, impurity additions are found to reduce the deviation from the parabolic law, $h = 1 - t^2$. The observations are explained by theoretical predictions of Clem for which the mean-squared anisotropy in pure tin is taken to be $\langle a^2 \rangle = .014 \pm .001$. (Diss. Abstr.)

**46072** STATISTICAL MECHANICS: FOUNDATIONS AND APPLICATIONS. Proceedings of the I.U.P.A.P. Meeting, Copenhagen, 1966. Bak, Thor A. (ed.). New York, W. A. Benjamin, Inc., 1967. 589p. (CONF-660727).

Separate abstracts were prepared for the three papers in scope for Nuclear Science Abstracts. (M.O.W.)

*For abstracts of individual papers see: 46073, 46178, and 46306.*

**46073** FLUCTUATIONS AND CORRELATIONS IN SUPERFLUID HELIUM. Martin, Paul C. (Harvard Univ., Cambridge, Mass. CEN, Saclay, France). pp 511-24 of Statistical Mechanics: Foundations and Applications. Proceedings of the I.U.P.A.P. Meeting, Copenhagen, 1966. Bak, Thor A. (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-660727.

The statistical mechanical approach to superfluidity is reviewed. The one-particle density matrix is discussed. Equations for perfect and slightly imperfect Bose gas are discussed. (M.O.W.)

**46074** LIQUID TEMPERATURE EFFECTS ON THERMALLY INFLUENCED TRANSITION CURRENTS OF Nb-ALLOY SUPERCONDUCTING SOLENOIDS IN He I AND He II. Frederking, T. H. K.; Linnet, C. (Univ. of California, Los Angeles). Advan. Cryog. Eng., 13: 80-91(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801–(Vol.2).

The effects of the liquid helium bath temperature on the quenching currents $I_c$ of degraded Nb–Ti alloys were studied at subatmospheric pressures. A simulation technique was applied to determine in particular the effects caused by thermal boundary conditions. A strongly dissipative section within the wire was placed inside the interior of a vertical tube (dia ⅛ to ⅜ in.) at its bottom. The tube had been covered with one layer of Nb–Ti windings (approximately 50 at. % Ti) and was closed at its bottom. The effects of the bath temperature T on the entropy flux leaving the upper tube exit at $I_c$ were found to be similar to previous results obtained for adiabatic tube walls with normal metal bottom heaters, i.e., there is evidence for a critical current enhancement below the λ-point caused by a change in thermal boundary conditions. For comparison, a few critical currents have been determined for Nb–25Zr solenoids which showed little change with temperature, as to be expected from the upper critical field function $H_{c2}(T)$, provided the solenoid was stabilized. (auth)

**46075** INVESTIGATION OF SUPERCONDUCTORS OF THE $M_3X$ TYPE WITH TWO OVERLAPPING ENERGETIC BANDS BY THE METHOD OF NUCLEAR MAGNETIC RESONANCE. Khotkevich, V. I.; Falko, I. I.; Serdyuk, A. D. (Kharkov State Univ.). Ukr. Fiz. Zh., 13: 694-5(Apr. 1968). (In Russian).

The temperature dependence of the spin–lattice relaxation time in superconducting alloys with overlapping electron energy bands was studied. The method of spin–lattice relaxation for finely dispersed structures or thin foils of superconducting materials, together with the ultrasonic method, was used in studies of two-zone superconductors of the $M_3X$ type (M is vanadium or niobium and X is gallium, silicon, tin or aluminum). (R.V.J.)

**46076** SUPERCONDUCTIVE TUNNEL JUNCTION NEURISTOR. Parmentier, Robert Dana. Madison, Wis., Univ. of Wisconsin, 1968. 103p.

Thesis.

Neuristor devices are of interest as the basic component of an artificial nervous system. A strip transmission line which utilizes electron tunneling through a thin insulator separating two superconducting metals can support propagation of neuristor pulses. Such superconductive neuristor lines are of two distinct types: (1) normal electron tunnel junction lines, in which the insulating layer is 30 to 50 Å thick, and (2) Josephson junction lines, in which the insulating layer is 10 to 20 Å thick. Dynamic steady-state analysis applied to the nonlinear partial differential equations which describe the normal electron tunnel junction line predicts the pulse propagation velocity (through Bendixson's criterion) and gives upper and lower bounds both for the bias current required for neuristor propagation and for the voltage amplitude of the neuristor pulse (through Poincaré's index rule). Linearized perturbation stability analysis shows that the neuristor pulse is unstable over at least the upper portion of the range of bias current values allowed by Poincaré's index rule. Experiments on a lumped circuit analog which uses Esaki diodes as active elements confirm the theoretical predictions of voltage pulse amplitude and propagation velocity and are consistent with the stability analysis. Experiments on thin film vacuum evaporated tin–tin oxide–lead normal electron tunnel junction lines give similar results, with voltage pulse amplitudes of 0.3 to 0.5 mv., propagation velocities of about $1.5 \times 10^9$ cm./sec. and stability only over a narrow range of bias current values. Dynamic steady-state analysis applied to a simplified model of the Josephson junction line predicts pulse propagation behavior similar to that on the normal electron tunnel junction line. Experiments on a tin/aluminum oxide/lead Josephson junction line confirm the bias current requirements for this mode of propagation; but the observed values of voltage pulse amplitude differ by an order of magnitude from the predicted values, and the observed propagation velocity depends upon the bias current, contrary to the theoretical prediction of a constant velocity. The observed behavior is, however, qualitatively similar to predictions of previously reported theories. Considerations of fabrication technology and power dissipation indicate that large systems of superconductive tunnel junction neuristors, having active element densities of $10^5$ per cubic inch or more, could be constructed. (Diss. Abstr.)

**46077** NUCLEATE COOLING STABILITY FOR SUPERCONDUCTOR-NORMAL METAL COMPOSITE CONDUCTORS IN LIQUID HELIUM. Whetstone, C. N.; Boom, R. W. (Atomics International, Canoga Park, Calif.). Advan. Cryog. Eng., 13: 68-79(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801–(Vol.2).

Total thermal stability in liquid helium is discussed for superconductor/normal metal composites employing nucleate cooling. This type of stability is most conservative in that the entire conductor current can be transferred to the normal metal without the composite becoming thermally unstable. The maximum conductor current capable of being stabilized by nucleate cooling is independent of the superconducting transition temperature. Measurements of conductor temperature show that the onset of thermal instability coincides with the nucleate-to-film boiling transition. Coils operated between 1.5 and 5.22°K show a marked increase in cooling below the λ point, a decrease near the critical point, and a broad relative maximum between 4 and 4.7°K. At 4.2°K the nucleate cooling is independent of conductor spacing over a wide range of spacings and has the value of 0.4 W/cm$^2$. Furthermore, no cooling limitation was noted for practical magnet charging rates. Analytical examples with reasonable sized conductors show that overall magnet current densities up to ~15,000 A/cm$^2$ can be expected for magnets designed with nucleate cooling. (auth)

**46078** ELECTRICAL AC LOSS MEASUREMENTS AND THERMAL CONDITION INVESTIGATIONS OF SUPERCONDUCTING COILS. Pech, T.; Fournet, G. (Faculte des Sciences de Paris, Fontenay-aux-Roses, France). Advan. Cryog. Eng., 13: 60-7 (1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801–(Vol.2).

An arrangement for measurement of the ac losses of superconductors by means of a Hall-effect device is described and the application experimentally verified. (auth)

**46079** PERFORMANCE OF SUPERCONDUCTING NbTi AND NbZr INORGANIC SOLENOIDS. Hintz, R. E. (Univ. of California, Berkeley). Advan. Cryog. Eng., 13: 51-9(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A continuing effort is being made at Berkeley to produce reliable moderate-size superconducting magnets of high current density. Several factors contributing to the attainment of reliability and high current density have been investigated. In general, attempts were made to run NbZr and NbTi superconductors near their short-sample limit with the minimum addition of copper and winding space. The ratio of copper to superconductor required to run the superconductor near its short-sample limit depends most on the size of the coil and thermal environment of the conductor. Other factors which have less effect on the current capacity of the conductor are controlled turn-to-turn shunting and copper foil interleaving. These last two factors were investigated because they might increase the current capacity of a coil without using a significant amount of coil space. Initially coils were constructed with controlled turn-to-turn shunts to increase their current capacity. It now appears that the coil protection that results from this construction is more important. The semiconducting shunts permit large coils of high current density to undergo safely a transition to the normal state. (auth)

**46080** OVERLOAD PROTECTION OF SUPERCONDUCTING ELECTRICAL POWER EQUIPMENT. Klaudy, P. A. (Technical Univ., Graz). Advan. Cryog. Eng., 13: 35-50(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

Owing to the extraordinary short time within which superconducting wires can go normal and to the low heat capacity of such wires after quenching, the question of overload protection of superconducting power equipment requires serious consideration. A report is given on the events arising in superconducting wires used in electrical power equipment in case of short circuit. In addition, adequate overload protecting devices developed in the Technical University of Graz are described. Finally, some problems related to the quenching process of superconducting wires as they are used in such protecting devices are discussed. (auth)

**46081** PERFORMANCE OF A COPPER-CLAD Nb–40 PERCENT Ti IN A HIGH-CURRENT-DENSITY 50-kG SUPERCONDUCTING SOLENOID. El Bindari, A.; Bernert, R. E.; Hoppie, L. O. (Avco-Everett Research Lab., Everett, Mass.). Advan. Cryog. Eng., 13: 30-4(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

The stabilization of copper-clad Nb–Ti superconducting wire, its heat treatment, and its use in an operating coil at 4.2°K are reported. (auth)

**46082** CRITICAL SURFACES FOR COMMERCIAL $Nb_3Sn$ RIBBON AND Nb–25 PERCENT Zr WIRE. Aron, P. R.; Ahlgren, G. W. (Lewis Research Center, Cleveland, Ohio). Advan. Cryog. Eng., 13: 21-9(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

The critical surface defining the boundary between the superconducting and the normal state has been determined for a sample of commercial vapor deposited $Nb_3Sn$ ribbon and a sample of Nb–25% Zr wire. The surfaces are defined over the range 2 to 18°K, 0 to 80 k gauss and 0 to 200 amperes, by a direct measurement of transverse critical current. The $Nb_3Sn$ data fit the Kim–Anderson expression over most of the range of variables and the temperature variation of the critical state parameters x and $h_0$ is determined. The Nb–Zr data fail to fit either Kim–Anderson expressions or the Fietz relation. (auth)

**46083** COMMERCIAL ASPECTS OF SUPERCONDUCTIVITY. Freeman, D. C. Jr. (Union Carbide Corp., Speedway, Ind.). Advan. Cryog. Eng., 13: 9-20(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

An examination is made of the technical aspects pertinent to the commercialization of superconductivity: personnel, raw materials, refrigeration, and dewars. Applications in magnets, electronics, and power equipment are discussed, and an attempt is made to estimate the market. (D.L.C.)

**46084** EMPIRICAL APPROACH TO SUPERCONDUCTIVITY. Matthias, B. T. (Univ. of California, La Jolla. Bell Telephone Labs., Murray Hill, N. J.). Advan. Cryog. Eng., 13: 1-8(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

The cooperative nature of superconductivity is pointed out, and other cooperative phenomena are discussed with a view toward developing an empirical theory of superconductivity. Some new relationships are found in the periodic system; superconductivity is found to be related to the melting point and hardness. It is concluded that, in order to raise the transition temperature, the electron shell must be deformed as well as the lattice, and the crystal structure must be cubic. (D.L.C.)

**46085** MICROWAVE PROPERTIES OF SUPERCONDUCTORS. Turneaure, J. P. (Stanford Univ., Calif.). Advan. Cryog. Eng., 13: 109-15(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A discussion of the microwave properties of superconductors related to the design of an accelerator is given. The following are considered: the temperature and frequency dependence of the surface resistance, the residual surface resistance, the surface resistance at large microwave fields, the critical magnetic field, and electric field emission. The proposed 500-foot electron linear accelerator at Stanford is expected to have an accelerator structure whose surfaces are superconducting, electroplated lead. The surface resistance of such surfaces is observed to be as low as $3 \times 10^{-6}$ of the surface resistance of copper at room temperature. (auth)

**46086** FLUX JUMP SIZE DISTRIBUTION IN LOW-$\kappa$ TYPE-II SUPERCONDUCTORS. Heiden, C.; Rochlin, G. I. (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 691-4(Sept. 2, 1968).

The size distribution of noncatastrophic flux jumps in cylindrical specimens of Pb–2 at. % In alloys in an axial, homogeneous, linearly swept magnetic field has been measured as a function of field at 4.2°K and found to approximate the form $N(\varphi) = N(0) \times \exp(-\varphi/\bar{\varphi})$, where the mean bundle size $\bar{\varphi}$ was of the order of $10^2\ \varphi_0$ to $10^4\ \varphi_0$. The fraction of the entering flux participating in the jumps was found to have a field dependence similar to that of $\bar{\varphi}$. When surface superconductivity was present, the jumping persisted up to $H_{c3}$. (auth)

**46087** MAGNETIC SUSCEPTIBILITY MEASUREMENTS IN VERY DILUTE SOLID SOLUTIONS OF $^4$He IN $^3$He. Cohen, H. D.; Pipes, P. B.; Verosub, K. L.; Fairbank, W. M. (Stanford Univ., Calif.). Phys. Rev. Lett., 21: 677-9(Sept. 2, 1968).

Measurements of the magnetic susceptibility of very dilute solid solutions of $^4$He in $^3$He as a function both of molar volume and of $^4$He concentration in the $\alpha$ phase have been made between 1 and 0.04°K by steady-state nuclear-resonance techniques. The most dilute solution ($5 \times 10^{-7}$ $^4$He) followed Curie's law over the range in molar volume (23.0 to 21.0 cc) measured. The less dilute solutions ($1 \times 10^{-4}$ and $3 \times 10^{-4}$ $^4$He) followed a Curie–Weiss law with relatively large, antiferromagnetic Weiss constants. (auth)

**46088** THERMODYNAMIC PROPERTIES OF DEUTERIUM. Prydz, R.; Timmerhaus, K. D. (Univ. of Colorado, Boulder); Stewart, R. B. Advan. Cryog. Eng., 13: 384-96(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A literature survey was made of existing data on the thermodynamic properties of deuterium. An equation of state was developed from the P–$\rho$–t data, and a vapor pressure equation was derived that fits the data from the triple point to the critical point. Calculated second virial coefficients are compared with experiment. The compilation of thermodynamic properties is presented in the form of temperature–entropy and compressibility factor charts for temperatures of 20 to 300°K and pressures of 0.1 to 400 atm. (D.L.C.)

**46089** PRELIMINARY THERMODYNAMIC PROPERTIES OF $^3$He BETWEEN $1^0$ AND $100^0$K. Gibbons, R. M.; McKinley, C. (Air Products and Chemicals, Inc., Allentown, Pa.). Advan. Cryog. Eng., 13: 375-83(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

The thermodynamic properties of $^3$He in the region 1 to 100°K and 1 to 100 atm are presented. Below 20°K, experimental PVT data were fitted to a modified Strobridge equation which was then used to obtain the enthalpy and entropy. Above 20°K, a modified version of the quantum version of corresponding state was used to predict values of the properties of $^3$He. (auth)

**46090** A $4.0^0$K SINGLE-ENGINE CYCLE HELIUM REFRIGERATOR. Meier, R. N.; Currie, R. B. (Air Products and Chemicals, Inc., Allentown, Pa.). Advan. Cryog. Eng., 13: 441-9(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A modified Claude-cycle helium refrigerator is described, in which a single reciprocating expansion engine is the sole source of refrigeration. Its load capacity is 1 watt at 4.0°K. The design

permits use of redundant compressor and expander for maximum reliability applications. A novel temperature control system is used and is capable of controlling load temperature to ±0.01°K. Design features and operating experience are summarized. (auth)

**46091** A CONTINUOUS HELIUM II REFRIGERATOR. Baldus, W.; Sellmaier, A. (Linde Aktiengesellschaft, Munich). Advan. Cryog. Eng., 13: 434-40(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A closed-cycle helium refrigerator is described with a refrigerator capacity of 30 Watts at 1.8°K. Alternatively the unit produces 8 liters per hour of liquid helium at normal pressure. The system uses liquid nitrogen and one piston expander for precooling. A two stage vacuum pump with a capacity of 3000 $m^3$/hr reduces the vapor pressure of the evaporating superfluid helium to a value of about 12 torr. With a pressure drop of about 3 torr, the vacuum helium is warmed up to nearly room temperature in a separate heat exchanger unit. (auth)

**46092** ADVANCES IN CRYOGENIC ENGINEERING. VOLUME 13. Proceedings of the 1967 Cryogenic Engineering Conference, Stanford University, Stanford, California, August 21-23, 1967. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1968. 761p. (CONF-670801-(Vol.13)).

A total of 77 papers are grouped under the following headings: superconductivity and its applications, fluid dynamics, material properties, thermal properties, refrigeration systems, instrumentation, safety, heat transfer, insulation systems, and cryogenic systems. Separate abstracts were prepared for 25 of the papers. Two papers on superconducting magnets have been previously abstracted; see NSA 21: 32289 and 46279. (D.L.C.)

*For abstracts of individual papers see: 45230-45234, 45271, 45778, 46074, 46077-46085, 46088-46091, 46093, 46657, 46668, and 47037.*

**46093** AN EXPERIMENTAL APPARATUS TO DETERMINE THE EFFECTS OF ALPHA IRRADIATION AT LIQUID HELIUM TEMPERATURE. Van Itterbeek, A.; Bruynseraede, Y.; Van Poucke, L.; Thys, W. (Instituut voor Lage Temperaturen en Technische Fysika, Leuven, Belgium). Advan. Cryog. Eng., 13: 92-4(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

An apparatus was developed for the alpha irradiation of superconductors at very low temperatures (4.2°K) to determine the effects of lattice defects on superconducting properties. The apparatus consists of a measuring vessel and an enclosure vessel, and includes a Wheatstone-bridge-type liquid-level indicator. The alpha sources ($^{210}$Po) and the sample holder are described in some detail. (D.L.C.)

# Plasma and Thermonuclear Physics

*Refer also to abstract 46072.*

**46094** (AED-C-03-20) PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. VOLUME 3, NO. 5. Hilsenbeck, D. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 188p. Dep.

455 articles of various aspects of plasma physics are listed. Subject and author indexes are included. (M.O.W.)

**46095** (TID-24666) QUARTERLY PROGRESS REPORT NO. 90. Zimmermann, H. J.; Harvey, G. G.; Mason, S. J. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). July 15, 1968. 283p. Dep. CFSTI.

Separate abstracts were prepared for the 10 sections considered in scope for Nuclear Science Abstracts. (M.O.W.)

*For abstracts of individual sections see: 45836, 45924, 46123, 46124, 46143-46146, 46193, and 46577.*

**46096** SOME EXPERIMENTS IN THE SELECTIVE DISSEMINATION OF INFORMATION IN THE FIELD OF PLASMA PHYSICS. Anthony, L. J.; Cheney, A. G.; Whelan, E. K. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Inform. Storage Retrieval, 4: 187-200(June 1968).

A small-scale, computer-based SDI (selective dissemination of information) system in plasma physics and related subjects is described. The system serves about 100 research scientists and engineers and uses title input only in order to minimize input costs. The implications of this approach and its effect upon the system parameters are discussed. Some comparison of the costs of the computer-based system with those of a manual system is made. Further experiments are described in which the service is expanded to external users on a world-wide basis, the aim being to compare, under controlled conditions, the parameters of the small-scale internal service with those of an external service on a wider scale. Some observations on the future development and organization of computer-assisted services are made and on their possibilities and the main problems which are likely to arise. (BBB)

**46097** FIZIKA PLAZMY. (Plasma Physics). Luk'yanova, S. Yu. (ed.). Moscow, Atomizdat, 1967. 95p.

Eleven articles are included on the problems of controlled thermonuclear synthesis, plasma converters, and plasma interactions with solids. Geometry of magnetic fields of convectively stable plasma configurations, external magnetic field influence on the steady-state distribution of potential in ion-electron streams, distribution of straight nonlinear magnetosonic waves in rarefied plasma, cascade plasma acceleration, and coaxial plasma accelerators with pulsed azimuthal and longitudinal magnetic fields are discussed in the first six articles. The device for producing monochromatic ions with up to 100-keV energy, low-energy ion penetration through metals, plasma cluster interactions with longitudinal magnetic fields, measurements of ion-atom collision cross sections at low energies and high-temperature plasma studies are covered in the last five articles. (R.V.J.)

## Confinement and Heating of Plasma

**46098** (IAE-1451) CLOSED SPATIALLY-PERIODIC MAGNETIC CONFIGURATIONS WITH MINIMUM B. Glagolev, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 44p. (In Russian). Dep.

Closed magnetic traps with a minimum B and consisting of identical sections of magnetic fields stable at certain cross sections were studied. The minimum B of the system was obtained by extending central lines of force as compared to peripheral. (tr-auth)

**46099** (IAE-1485) TURBULENT PLASMA HEATING IN TORUS. Fanchenko, S. D.; Demidov, B. A.; Elagin, N. I.; Perepelkin, N. F. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 8p. Dep.

An investigation was made in order to determine whether a turbulent-heated torus-shaped plasma could eventually be confined after heating current cutoff. The experiment was carried out in the toroidal discharge chamber of the "Vikhr-2" device. Measurements of oscillations after current cutoff are presented. (M.O.W.)

**46100** (IAE-1488) PARTICLE DRIFT MOTION IN A SYSTEM WITH MINIMUM B. Skosyrev, Yu. V.; Yurchenko, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 12p. (In Russian). Dep.

Particle in-flight motion in a system with helical magnetic axes and stabilizing fields securing a minimum B was studied. Experimental data are presented for rotational transformation angles and drift surface configurations, and theoretical and experimental correlations are discussed. (R.V.J.)

**46101** (IPP-1/80) HIGH-FREQUENCY ANALOGUE MODEL FOR MEASURING MAGNETIC FIELD DISTURBANCES IN A THETA PINCH COIL. Hartz, F.; Junker, J.; Wolf, G. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1968. 21p. (In German). Dep.

An analogue experiment for measuring the magnetic field of a theta pinch coil is described. The magnetic field is produced in a model coil with a high-frequency generator (714 kHz) and is measured with an induction coil (approx. 1 mm in diam.) by comparison with a reference voltage. This configuration allows field disturbances of as little as 0.05% to be measured. A 2-mm-wide slit between the segments of a cylindrical theta pinch coil 5 cm in radius disturbs the uniform field at the inner wall of the discharge vessel (r = 4.25 cm) by 0.8%. The rotational symmetry of the field is disturbed by a 10 mm × 15 mm observation window. For a radius of 4.25 cm this disturbance is 6.5%, decreasing to 0.24% for r = 2 cm. In a theta pinch coil the linear diameter of which varies periodically in the axial direction ($r_{min}$ = 5.3 cm; $r_{max}$ = 5.8 cm; length of period = 10 cm), the rotational symmetry of the field is disturbed by the collector slit. With a collector slit 1-mm wide the measured disturbance at r = 4.9 cm is −1.3% at the "dents" (i.e., a cross section with $r = r_{min}$) and + 1.1% at the "bumps" (i.e., a cross section with $r = r_{max}$). This disturbance decreases with the radius to −0.2% and +0.4% respectively at r = 3 cm. From r = 4.9 cm to the axis the magnitude of the undisturbed field decreases 10% at the dents and increases

10% at the bumps. In the axial direction the field decreases from the cross section at a dent to that at a bump by 25% at r = 4.9 cm and ~5% near the axis. (auth)

**46102** (IPP–4/50) CAPACITOR BANKS FOR A TURBULENCE HEATING EXPERIMENT. Herppich, G.; Knobloch, A.; Mueller, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 44p. (CONF-680710–2). Dep.

From 5th Symposium on Fusion Technology, Oxford, England.

A fast main bank for a turbulence heating experiment, designed for multipurpose application, was operated at 40 kV; it has now been subdivided into a pre-ionization and a compression bank. The compression bank stores 8 kJ at 40 kV and delivers 554 kA with a rise time of 570 nsec. The bank is connected by sandwich conductors to a symmetrically double-fed linear coil. The coil length 60 cm is equal to the collector width; the coil diameter is 15.8 cm. Special components of the bank system are the collector system, the pressurized combined start and crowbar spark gaps, and the suppressor units at the collector for reducing line reflections. One-sixth of the former main bank was sliced off as a theta-pinch preionization bank. The data are 1.6 kJ, 40 kV, 813 kHz. To avoid faulty ignition of the spark gaps by voltage pulses coming from the pre-ionization bank, suppressors were connected at the spark gaps of the main bank. The bias field bank feeds a special multiturn coil surrounding the main coil in order to get a special axial distribution of the bias field. In order to avoid high voltages (about 1 MV) which would be induced in the bias field coil, voltage suppressors were developed. For sustained field experiments the bias field bank can also be connected directly to the main coil. (auth)

**46103** (IPP–4/52) PRESSURIZED SWITCHING UNIT DESIGNED TO START AND TO CROWBAR A TURBULENCE HEATING EXPERIMENT. Klement, G.; Mueller, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 37p. (CONF-680710–1). Dep.

From 5th Symposium on Fusion Technology, Oxford, England.

A start spark gap and a ferrite decoupled crowbar gap, molded together in an epoxy resin pressure chamber of outer size 20 × 14 × 10 cm, are described. The switch originally designed for switching the main bank of a 40-kV, 400-kHz turbulence heating experiment, and also used later for discharging the associated theta pinch pre-ionization bank, could afford a wide range of application. As arranged in this experiment, the main bank of which has a double transit time of only 20 nsec, the start gap must have a jitter of less than 10 nsec over a range of about 1:3, when triggered by a 50-kV pulse voltage of 80-nsec rise time. The inductance of the start gap is 35 nH, while the crowbar gap has a saturated inductance of 180 nH, which could be reduced by modifying the trigger circuit. The experience in testing and operating 60 units, with the associated trigger circuits and such data as delay, jitter, prefiring rate, and stability to voltage transients, is reported. Investigations on pulse breakdown, depending on trigger voltage characteristics up to ten atmospheres, and the influence of gap spacing are discussed, with regard to spark gap development, in the Appendix. Potential plots of some static and triggered cases are given also. (auth)

**46104** (IPP–4/57) GENERATION OF RAPID RISE CURRENT PULSES IN THE MSEC RANGE FOR FAST COMPRESSION EXPERIMENTS. Knobloch, A.; Herppich, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 54p. (CONF-680710–6). Dep.

From 5th Symposium on Fusion Technology, Oxford, England.

It seems that in the field of shock heating and fast compression experiments it might be worthwhile to increase the length of discharge vessels by about one order of magnitude. In order to optimize the lumped parameter capacitive energy storage systems for such applications, the design considerations, which were briefly mentioned in Frascati in 1966, have been extended. When assuming certain practical geometric arrangements and assuming the voltage dependence of the several components to be linear in a limited range, one arrives at the following equation for the primary bank generating the rapid rise: $\omega^2 (E^*/n) = (1 - \eta/K_s)$ where $\omega = 2\pi$ times the discharge frequency; $E^*/n$ = stored energy per unit length of coil divided by the number of banks connected in series; $\eta$ = energy efficiency; and $K_s$ = storage constant. $K_s$ consists of geometry factors and specific stress values, i.e., it is a measure of the technical standard applied. Relations for the determination of capacitor bank components as well as physical dimensions, numbers, and storage costs will be given. The conditions for producing relatively long current pulses with the same coil which generates the rapid rise have been investigated. One arrives at relations which determine the data of the constant current source in terms of the optimized primary bank. The form of the constant current source has to be chosen according to the conditions of the special case. Some possibilities are discussed. (auth)

**46105** (IPP–4/58) ISAR II: A 500 kJ DOUBLE-FED LINEAR THETA-PINCH. Klement, G.; Knobloch, A.; Kunze, R. C.; Nuetzel, G.; Schlageter, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 69p. (CONF-680710–5). Dep.

From 5th Symposium on Fusion Technology, Oxford, England.

Two half-banks of 250 kJ each are discharged into a double-fed coil. This design allows the high frequency of about 90 KHz and a better symmetry of the magnetic field configuration. The experiment can be run with partial energy (steps of 20% of the maximum), where for every possible energy step the feed of the current is axisymmetric with respect to the minor axis for a linear coil and point symmetric for a single fed torus. Making the collector width equal to the coil length in the linear case, any change from a linear coil to a toroidal one will be relatively easy. The geometrical design of the installation was governed by these features. In order to get close packaging of the load cables at the load, plug-in contacts were developed. The arrangements of the complete installation and the auxiliary units, which were determined by the special conditions, are described. The experiment is equipped with a premagnetization bank and a theta-pinch preionization unit. The assembling of the banks and, in some cases, the manufacture of some components were supervised with the aid of job planning techniques. The experience with these techniques is discussed. (auth)

**46106** (IPP–4/60) A SYSTEM OF SUPERCONDUCTING COILS 5 cm, 17 cm, AND 35 cm IN DIAMETER. Oswald, B.; Amenda, W.; Krueger, P.; Lohnert, H.; Mayer, P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1968. 19p. (CONF-680710–7). Dep.

From 5th Symposium on Fusion Technology, Oxford, England.

In order to prove the feasibility of large superconducting coils in plasma physics, a number of module-type standard coils were developed and tested. Various numbers of three different coil types can be combined to form variable field geometries. The maximum field provided would be about 100 kG. The test results are compared with the short sample characteristic of the different superconducting materials, such as $Nb_3Sn$ tape and NbTi composite cable. (auth)

**46107** (IPP–6/64) SOME THEORETICAL ASPECTS OF PLASMA HEATING BY HIGH FREQUENCY FIELDS. Wimmel, H. K. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1968. 28p. (CONF-680113–2). Dep.

From Conference on Interaction of Stationary and Progressive Electromagnetic Fields with a Plasma, Saclay, France.

Theoretical work done at Garching on plasma heating by high-frequency electromagnetic fields is reported. Three subjects are covered: (1) a time-dependent calculation of plasma density and electron kinetic temperature in an ECR-produced, mirror-confined plasma; (2) a relativistic, single-particle analysis of the maximum ECR energy in a mirror configuration; and (3) theoretical study of cyclotron waves propagating in a hot plasma cylinder (solution of the Vlasov equation). (auth)

**46108** (JUL–538–PP) THE ENGINEERING OF A HELICAL HARD CORE THETAPINCH EXPERIMENT (TESI). Friedrich, F. J.; Kohlhaas, W.; Stickelmann, C. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). June 1968. 15p. Dep.

A fast theta-pinch experiment was modified by inserting a helical hard core on its axis. This coil consists of 12 parallel wires imbedded in a glass-fiber reinforced epoxy rod. At both extremities, the wires are parallel to the axis of the rod. In the central part, over 30 cm, they are wound with a pitch angle of 45°. By this arrangement it should be possible to produce a compact toroidal plasma and to study its confinement time and stability. Initially, the diameter of the theta-pinch coil will be 20 cm and that of the hard core 4.5 cm. The theta-pinch coil and the hard core are energized by a 40-kV, 15-kJ capacitor bank and a 60-kV, 21-kJ bank, respectively. The design of the hard core and of the 60-kV capacitor bank is reported. (auth)

**46109** (JUL–540–PP) SAFETY PROBLEMS IN THE JULIETTA CAPACITOR BANK. Friedrich, F. J.; Liedtke, A. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). June 1968. 17p. Dep.

In 1967 the capacitor bank was extended to an energy of 1.2 MJ and a crowbar system installed. A survey of the bank characteristics and of the safety principles which were followed is presented. The probability of breakdowns in a system where currents of some 10 MA are flowing was decreased by dividing the bank and the collector, which is of the multi-plate type, in elements. The danger resulting from prefiring and misfiring of start gaps has been eliminated by charging rapidly the master-trigger generator at the end of the charging cycle and by increasing the corresponding capacity. Initially, a rather complicated electronic current mon-

itoring system was installed. The reliable operation of the start gaps allowed one to later simplify the setup: the potential differences between units are followed, indicating directly the location of the eventually defective start gap. Each crowbar gap was provided with a fast-acting current detector. When a prefire occurs, all the remaining crowbar-gaps are triggered almost instantaneously. By keeping the transit times as short as possible, the delay has been reduced to 1 μsec. Defects in the electronic master control system could lead to a misfire of the whole crowbar system and eventually to the destruction of the discharge tube. A second slightly slower trigger path, using delay lines and spark gaps exclusively, was built in. The charging voltages of spark gaps and thyratrons in the crowbar trigger system are monitored: if they are missing, a blocking signal is transmitted into the master control system. (auth)

**46110** (LA-DC-9507) THE DESIGN OF SCYLLAC: A 15-METER THETA-PINCH MACHINE. Kemp, Edwin L. (Los Alamos Scientific Lab., N. Mex.). [nd]. 26p. (CONF-680710-4). Dep. CFSTI.

From 5th Symposium on Fusion Technology, Oxford, England.

Scyllac is a theta-pinch machine 15-m long with a 10-cm coil diameter. Two versions will be built, a 15-meter linear model and, later, a 15-meter circumference toroidal model. The same capacitor bank and collector plates will be used for both versions. The machine will be divided into 15 coil, collector plate sections. The 720-kJ primary bank for each section will consist of 216 capacitors, each capacitor having a spark gap and 6 low-inductance coaxial output cables. The cables from each pair of capacitors will terminate at the collector plate in a low-inductance cable cartridge termination. Each collector plate will also have a high-frequency $B_z$ preionization system and a reverse bias, $B_\theta$ system. The toroidal system will also include static and dynamic stabilization systems. The design of Scyllac is proceeding in three phases: component development, system development, and system design. The main components being developed are: 1.85-μF, 60-kV capacitor; reliable low-inductance coaxial cable; a low-jitter, 60-kV spark gap; a metal-to-metal, solid dielectric crowbar switch; a low-inductance, cable cartridge termination; plug-in connectors, and miscellaneous hardware. After the components have been approved by the development laboratory they are purchased in substantial quantities and installed and tested in a prototype system. The components which qualify in the prototype system are used in the Scyllac system design. This paper will describe the component developments, the prototype system testing program, and the design of the complete Scyllac system. (auth)

**46111** (MATT-592) PLASMA CONTAINMENT IN A QUADRUPOLE CONFIGURATION. Harries, W. L.; Yoshikawa, S.; Palladino, R. W. (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1968. Contract AT(30-1)-1238. 32p. Dep. CFSTI.

The containment times of afterglow plasmas in hydrogen, helium, and neon were measured in a linear quadrupole machine (LM-1), where $n_e \lesssim 2 \times 10^{12}$, $T_e \lesssim 10$ eV, $T_i < 1$ eV, mean free path $\lambda \lesssim 100$ cm, connection length $\approx 20$ cm, and electron–ion collision time $\approx 10^{-7}$. Particle collectors showed the losses to be mainly radial. The plasmas in the $\oint dl/B$ stable region decayed in times of order a millisecond (about 10 times the Bohm value) which increased with $I_Q$, the conductor current, to a roughly constant value, and decreased as $T_e$ increased. An axial magnetic field which introduced shear ($\theta \geq 1/30$ radians/cm for the main plasma) caused negligible change to the containment time in helium, with a slight improvement in neon. Various instabilities were observed. Pronounced variations in probe signals and plasma loss rates at different axial positions suggested a convective structure which persisted in the afterglow for some milliseconds. The origin of the radial loss inside the stable region may be due to a low-frequency flute-like mode or possibly to the convective structure in the plasma. (auth)

**46112** (MATT-618) COMPUTER SIMULATION OF PLASMA CONFINEMENT IN A STELLARATOR. Smith, Craig G.; Bishop, A. S. (Princeton Univ., N. J. Plasma Physics Lab.). July 1968. Contract AT(30-1)-1238. 27p. (CONF-680805-18). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

The time-dependent approach to, and stability of, low-density equilibria in toroidal geometry is studied by simultaneously integrating the guiding-center equations of motion for a vast number of particles characterized by a distribution of parallel and perpendicular energies and initial positions. A static magnetic field which models the major effect of stellarator helical windings is used for the calculation, but the self-consistent, time-evolving electric fields are included in the dynamics. Axial symmetry is imposed, but motions parallel to the magnetic field are treated since these are projected on the cross-sectional plane by the rotational transform. Consequently the effect of mirroring and of a parallel electric field are included. In particular, the motion of electrons along field lines to cancel the charge imbalance due to curvature drifts is explicitly treated. In the single calculation performed thus far, the development of azimuthally asymmetric potential surfaces has been observed. This is primarily an m = 1 perturbation, the energy of which undergoes growth on the order of a Bohm confinement time and then slight decay thereafter. The long-time evolution occurs in the up–down (with respect to the toroidal plane) asymmetry; the in–out asymmetry, after an initial flip of sign, persists in a fashion which reinforces the trapping of electrons by the toroidal structure of the magnetic field. Superimposed are fluctuations with a period equal to the time required for electrons to move from the top to bottom of the machine by streaming along the field lines. The outward transport of electrons by $\vec{E} \times \vec{B}$ drifts is small. (auth)

**46113** (MATT-Trans-58) CLOSED SPATIALLY PERIODIC MAGNETIC CONFIGURATIONS WITH MINIMUM B. Glagolev, V. M. Translated for Princeton Univ., N. J., from report IAE-1451. 64p. Dep. CFSTI.

An investigation was made of closed magnetic traps with minimum "B" consisting of segments of magnetic fields having stability in a defined cross section. The minimum "B" in the systems is obtained as a result of lengthening the central lines of force as compared to the peripheral lines of force. (auth)

**46114** (N-68-24459) CURRENT HEATING OF PLASMA IN A CLOSED MAGNETIC TRAP. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Nikolaev, R. M.; Potapenko, V. A.; (and others) Translated from pp 132-8 of Vzaimodeystviye Zaryazhennykh Chastits S Plazmoy, Kiev, Naukova Dumka Press, 1967. 7p. (NASA-TT-F-11629). CFSTI.

Experimental investigation was made of the effect of accelerated electrons on plasma characteristics in a closed magnetic trap. The experiments consisted of measurements of the current flow, plasma density, x radiation, microwave radiation, and light emission as functions of the accelerated particle density. (auth) (STAR)

**46115** (NP-17516) ISSLEDOVANIE VZAIMODEISTVIYA PLAZMENNYKH SGUSTKOV S POPERECHNYM MAGNITNYM POLEM. (Investigation of the Interaction of Plasmoids with a Cross-Sectional Magnetic Field). Demidenko, I. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 75p. (In Russian). Dep.

Thesis.

The possibility of introducing plasmas, produced by plasma injectors, into magnetic traps is considered in a discussion with a survey character. The characteristics of the movement of the plasma across the magnetic field are examined. The results of the investigation of the polarization interaction of plasma beams in transverse magnetic fields and the results of transverse injection of plasma into active magnetic traps are described. The experimental devices and the experimental methods used in the study of the interaction of plasmoids with a transverse magnetic field are described. The basic results of the experimental study are reported. The properties of the plasma trapped by the field and moving along it and of plasmas after their passage through the magnetic field were determined. The mechanism for the capture of moving plasmas by transverse magnetic fields was studied. The possibility of developing instabilities in plasma trapped by a transverse magnetic field was examined. (tr-auth)

**46116** (UCRL-71022) TESTING COMPOSITE SUPERCONDUCTOR FOR THE LRL BASEBALL MAGNET. Nelson, Robert L.; Henning, Carl D. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1, 1968. Contract W-7405-eng-48. 19p. (CONF-680813-2). Dep. CFSTI.

From Cryogenic Engineering Conference, Cleveland, Ohio.

Testing of a square composite superconductor to be used in the large baseball magnet now under construction at LRL Livermore is described. Sample conductors, purchased from five suppliers, were comparable in quality and performance to that required for the baseball magnet. To produce the external magnetic field for conductor testing, a "split-pair" magnet was built of niobium–tin superconducting tape. The solenoids of each sample superconductor were located in the high field region between the halves of the "split-pair" magnet, and then energized. For comparison, the short-sample conductor performance was measured and plotted along with the solenoid performance. In addition, a correlation was obtained between current-sharing characteristics of a superconductor and magnet stability. (auth)

**46117** FORMATION AND STABILITY OF VIRTUAL ELECTRODES IN A CYLINDER. Hockney, R. W. (Stanford Univ., Calif.). J. Appl. Phys., 39: 4166-70(Aug. 1968).

Two-dimensional computer experiments have been performed to

determine whether a stable virtual electrode can be formed inside an evacuated cylinder by the injection of charged particles from the outside. This question is important to the feasibility of certain inertial confinement schemes for fusion reactors. The charges are injected with constant velocity uniformly from the surface of the cylinder and directed at the axis. Above a certain current, depending on the injection velocity and dimensions, dc solutions exist corresponding to the formation of a virtual electrode at a calculable radius within the cylinder. Such analytic solutions involving virtual electrodes are not necessarily realized in practice as they were not in the one-dimensional computer experiments of Birdsall and Bridges on the short-circuited diode. The problem discussed here, although related to the diode, is different both in geometry and in the manner of injection. It is interesting that our computer experiments show the formation of a stable virtual electrode for a wide range of input current. Such variations of potential that do occur are transient and decay to less than ±2% after ten single-particle transit times. Experiments have also been conducted with the current injected from four separate guns. Stable virtual electrodes are formed in this case opposite each gun. (auth)

**46118** INVESTIGATION OF HEATING OF A PLASMA BY A FAST LARGE AMPLITUDE MAGNETOACOUSTIC WAVE. Vasil'ev, M. P.; Grigor'eva, L. I.; Longinov, A. V.; Smerdov, B. I.; Chechkin, V. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 54: 1646-58(June 1968). (In Russian).

Resonance excitation and absorption of a fast magneto-acoustic wave in an hydrogen plasma is measured in the frequency range $\omega_i \lesssim \omega \ll \sqrt{\omega_e \omega_i}$ ($\omega_i$ and $\omega_e$ are, respectively, the ion and electron cyclotron frequencies and $\omega$ is the wave frequency) and at plasma densities between $10^{13}$ and $10^{14}$ $cm^{-3}$. The variable field in the plasma is generated by a coil consisting of several sections each pair of which is antiphased. The coil is the inductance of a shock circuit accumulating up to 10 joules energy and possessing a frequency of $7 \times 10^6$ c/s. Up to 70% of the energy accumulated in the circuit is transferred to the plasma during resonance excitation of the fast magneto-acoustic wave. The amplitude of the varying magnetic field in the plasma reached 500 Oe in this case. A rapid (≤1 μsec) heating of electrons up to a mean energy of about 200 eV and of ions up to ~20 eV occurred. The velocity distribution of electrons and ions emitted from the plasma along the stationary magnetic field is measured for high and low amplitudes of the high-frequency field. Possible mechanisms which can explain the observed wave attenuation and plasma heating are discussed. (auth)

**46119** ONE METHOD OF ELECTRON HEATING IN A CLOSED MAGNETIC TRAP. Volosov, V. I.; Komin, A. V. Zh. Tekh. Fiz., 38: 846-50(May 1968). (In Russian).

The method of stochastic acceleration of electrons in a variable electric field (analogous to Fermi acceleration in the one-dimensional case) is proposed for the production of low-density plasma in the accelerator. The accelerating electric field, parallel to the magnetic field, for realization of the stochastic conditions is concentrated on a small part of the toroidal chamber. The longitudinal energy of the electrons can be much greater than the amplitude of the accelerating voltage. The upper limit of the plasma density was determined from the equality of the skin-layer thickness of the transverse dimensions of the plasma. The method can be used for ion heating. (tr-auth)

## Diagnostics of Plasma

*Refer also to abstracts 45370 and 45985.*

**46120** (IPP-4/51) PRECISE MEASUREMENT OF H.F. FIELDS IN MODELS. Herppich, G.; Mantel, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1968. 46p. (CONF-680710-3). Dep.

From 5th Symposium on Fusion Technology, Oxford, England.

To gain performance and stability in plasma heating devices, an exact hf field distribution and homogeneity must be determined. The calculation of the field distribution in complex geometry turned out to be very cumbersome. Measuring methods with high accuracy and stability for sine waves and pulses are demonstrated and analyzed. (auth)

**46121** (MATT-Trans-61) STUDY OF PLASMA TURBULENCE IN A HIGH CURRENT TOROIDAL DISCHARGE BY MEANS OF SUPERHIGH-FREQUENCY PROBING. Larionov, M. M.; Rozhdestvenskii, V. V. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., N. J. 20p. Dep. CFSTI.

Measurements were made of turbulent plasma in the "Al'fa" device, a high-current toroidal discharge stabilized by a weak longitudinal magnetic field and a conducting housing, and data are presented. (M.O.W.)

**46122** (N-68-24571) ULTRA-HIGH TEMPERATURE MEASURING TECHNIQUES. Final Report. Freyheit, P. J.; Nygaard, K. J.; Norcross, D.; Stone, P. M. (Sperry Rand Research Center, Sudbury, Mass.). May 1968. Contract NAS12-86. 140p. (NASA-CR-86055; SRRC-CR-68-17). CFSTI.

Development of a real-time technique for measuring gas temperatures above 5000°K in an air-nitrogen plasma was investigated using an air plasma in the temperature range from 5,000 to 24,000°K at light densities in the range from 10 times normal to $10^{-6}$ times normal. The temperature measurement techniques considered were Doppler line broadening, line intensity ratios, line-to-continuum intensity ratios, and measurement of particle density with subsequent calculation of temperature. Two methods, line intensity ratios and Doppler broadening, covered the range adequately. A real-time temperature-measuring system employing these methods would use photomultiplier tubes as detectors and incorporate an independent means (e.g., Stark broadening) of measuring electron density. In investigations of a hot cesium seeded hydrogen plasma, the influence of cesium seed fraction on the cesium-hydrogen plasma photoabsorption coefficient was determined over the pressure range from 0.1 to 100 atmospheres. Spectroscopic techniques for measuring the temperature of hot cesium seeded hydrogen were also analyzed, and a procedure for determining temperature using the Stark broadened width, line center absorption coefficient, and emission energy of selected lines is presented. (auth) (STAR)

**46123** (TID-24666, pp 85-91) SYSTEM D: SPECTROSCOPIC MEASUREMENT OF THE ION TEMPERATURE. Mangano, J. A.; Smullin, L. D. (Massachusetts Inst. of Tech., Cambridge).

Experimental and theoretical work to determine plasma ion temperatures for spectroscopic measurements is briefly described. Preliminary results taken for helium are discussed. (M.O.W.)

**46124** (TID-24666, pp 92-5) HEXAPOLE EXPERIMENT. Herba, F.; Parker, R. R. (Massachusetts Inst. of Tech., Cambridge).

Spectrum measurements of the signal detected by an electrostatic probe in the plasma were made. Results of runs taken at different magnetic fields and constant pressure and beam conditions are given. (M.O.W.)

**46125** MICROWAVE DIAGNOSTICS FOR MEASURING VERY LOW ELECTRON DENSITIES IN AFTERGLOW PLASMAS. Weaver, L. A. (Westinghouse Research Labs., Pittsburgh); Freiberg, R. J. J. Appl. Phys., 39: 4283-6(Aug. 1968).

An extension of conventional microwave-cavity diagnostic methods is described which is capable of measuring very low electron densities occurring late in afterglow plasmas. Electronic signal sampling and pulse-stretching techniques are combined with phase-sensitive detection to provide a sensitive measure of the shift in cavity resonance during selected 0.5 μsec intervals of the afterglow. By employing a synchronous source frequency-compensation scheme, electron densities as low as $n_e \sim 2 \times 10^4$ $cm^{-3}$ were measured in helium afterglows at 0.4 and 4.0 torr. A comparison with conventional cavity techniques for $n_e \sim 10^9$ $cm^{-3}$ shows good agreement between the two methods. The application of such low density measurements to transition diffusion studies is discussed. (auth)

**46126** LEKTSII PO DIAGNOSTIKE PLAZMY. (Lectures on Plasma Diagnostics). Podgornyi, I. M. Moscow, Atomizdat, 1968. 220p.

Methods used for the laboratory studies of high-temperature plasma and plasma diagnostics are discussed. Oscillographic recording of currents and voltages in pulsed thermonuclear devices, probe methods in plasma studies, determination of temperature by the intensity of line spectrum emission, and determination of plasma parameters by the spectral lines are discussed in the first four chapters. The continuum spectrum, concentration and electron temperature, super-high speed photography and dielectric plasma penetrability are covered in the next three chapters. The last two chapters are concerned with corpuscular methods for plasma diagnostics and measurements of accelerated plasma clusters. Each chapter includes a brief list of references. (R.V.J.)

**46127** CRITICAL APERTURE IN PLASMA DIAGNOSTICS BY THE SCATTERING METHOD. Pyatnitskii, L. M.; Khaustovich, G. P.; Korobkin, V. V. (Krzhizhanovskii Power Engineering Inst., USSR). JETP Lett. (USSR) (Engl. Transl.), 17: 378-81(June 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 493-6(June 20, 1968).

In plasma diagnostics by scattering of laser emission from free electrons, the plasma parameters are determined by analyzing the

density distribution of the scattering spectrum. The density of the spectrum is proportional to the scattering cross sections and to the solid angle $\Delta\Omega$ in which the scattered light is gathered. Collective effects in the plasma result in the appearance of satellites in the spectra. As the observation angle $\Delta\Omega$ is increased, broadening of the satellite occurs. The critical value of $\Delta\Omega$ at which the satellite broadening can be neglected is calculated. It is concluded that the critical values of $\Delta\Omega$ are much lower than the observation angles usually encountered in experiments; this may explain why temperatures calculated from the spectra are higher than expected. (A.G.W.)

**46128** MEASUREMENT OF ION VELOCITY DISTRIBUTIONS IN LOW-DENSITY PLASMA BEAMS. Liebing, Lotar F. C. (General Dynamics/Convair, San Diego, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1763-8(Sept. 1968).

A new probe has been developed to measure the ion velocity distribution function in low-density ($10^8$ to $10^{12}$ particle/cm$^3$) plasma beams. The ion velocity can range from small values such as $10^3$ cm/sec to $5 \times 10^5$ cm/sec. The operation of the probe is based on a time-of-flight measurement between a fast plasma shutter and an ion collector. The probe has been tested in pulsed and steady-state plasma beams. (auth)

**46129** RADAR INTERFEROMETRY MEASUREMENTS OF A TURBULENT PLASMA. Weissman, D. E.; Guthart, H.; Morita, T. (Stanford Research Inst., Menlo Park, Calif.). Radio Sci., 3: 874-7(Aug. 1968).

A laboratory experiment has been conducted that demonstrates the applicability of radar interferometry to the measurement of the width of a turbulent plasma column. This is done by inferring the spatial distribution of the incoherent electromagnetic power back scattered from the column. The measurements of the spatial correlation of the backscattered electromagnetic fields are in good agreement with a function derived theoretically by using extensive diagnostic data. (auth)

**46130** DETERMINATION OF THE SPATIAL DISTRIBUTION OF THE PLASMA DENSITY BY MEANS OF PHASE MEASUREMENTS. Gorbunov, E. P.; Dnestrovskii, Yu. N.; Kostomarov, D. P. Zh. Tekh. Fiz., 38: 812-17(May 1968). (In Russian).

Questions connected with the determination of the spatial distribution of the plasma density as a result of the phase measurement of the displacement of the electromagnetic wave with frequency $\omega^2 \gg \omega_p^2$ were considered. The problem was solved in the general case without assumptions on the axial symmetry of the distribution with decomposition into the Fourier series of the phase functions and spatial functions of the plasma density. (tr-auth)

**46131** DENSITY MEASUREMENT OF PLASMA BY $CO_2$ LASER INTERFEROMETER. Miyamoto, Kenro (Nagoya Univ., Japan); Yamamoto, Junya. Kakuyoga-Kenkyu, 21: 150-6(Aug. 1968). (In Japanese).

A method of using a $CO_2$ laser interferometer for density measurement in the intermediate region is described (the product of density n and plasma diameter d is around $10^{15}$ cm$^{-2}$). A Michelson-type interferometer is adopted and one-tenth of the fringe corresponds to $n \times d \simeq 1.05 \times 10^{15}$ cm$^{-2}$. A Ge(Cu) photoconductor cooled by liquid helium is used as a detector with fast time response. These are applied for the density measurement of plasma of BSG device and it is confirmed that this method is reliable and easy technique for the purpose. (NSA of Japan)

**46132** MEASUREMENTS OF SLOW THETA PINCH PLASMA BY MACH–ZEHNDER INTERFEROMETER WITH GIANT PULSE RUBY LASER. Hayase, Kiyoshi; Miyamoto, Kenro (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 21: 168-80(Aug. 1968). (In Japanese).

Space and time resolved Mach–Zehnder interferometer is applied to study a slow theta-pinch plasma. Methods of timing operations and experimental arrangements are described. The plasma is pinched in the third half-cycle of the discharge period. The interferogram shows that the peak electron density varies from about $1 \times 10^{16}$ to $1 \times 10^{17}$ cm$^{-3}$ as the filling gas pressure is varied from 25 to 400 mtorr. The radial distribution of shell structure is observed when a small reverse bias field is added. The relaxation time of this field is longer at the lower gas pressure. In the pressure range higher than 40 mtorr, a flute-type instability appears. But no drift motions are observed. Interferograms show various modes of instabilities. The loss rate of the total number of electrons is estimated and the result is in good agreement with a theoretical model of steady magnetohydrodynamic fluid. (NSA of Japan)

**46133** MEASUREMENT OF THE TEMPERATURE OF PLASMA FROM PULSE DISCHARGE IN DEUTERIUM BY SELF-REVERSAL OF THE SPECTRAL LINES. Berezin, I. A.; Kuznetsov, F. O.; Model, I. Sh. Zh. Prikl. Spektrosk., 8: 13-16(Jan. 1968). (In Russian).

The change of the contour of the self-reversed spectral lines $D_\alpha$ from the time of the pulse discharge in deuterium was investigated. By means of the Bartel method, the value of the temperature and its variation with time were evaluated. In the first half-period of the discharge the temperature rapidly increases, attains a maximum value, and then evenly decreases. With increase of the gas temperature, the maximum value of the temperature decreases. The results compare with the temperature measurements by the brightness of the continuum. The Bartel method makes it possible to trace the temperature in a wider time interval than the continuum brightness method, obviously, very accurately to reproduce the time pattern of the temperature. (tr-auth)

## *Kinetics of Plasma*

**46134** (IAE-1455) INSTABILITY OF PERIODIC MAGNETO–ACOUSTIC WAVES. Petviashvili, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 11p. (In Russian). Dep.

An asymptotic method was used in the theory of nonlinear oscillations in studies of small perturbations in periodic magneto–acoustic waves propagating across a magnetic field in hot plasma or plasma in solids. It was found that such a wave with comparatively high amplitude is unstable and excites long-wave slow plasma density fluctuations. (tr-auth)

**46135** (IAE-1486) INFLUENCE OF THE INTERELECTRODE DISTANCE ON THE STABILITY OF STRAIGHT PINCH IN A QUADRUPOLE HIGH-FREQUENCY FIELD. Morozov, V. E.; Orlinskii, D. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 16p. (In Russian). Dep.

Experimental studies were made of the influence of long-wave deformations in a straight plasma pinch on its stability in a quadrupole high-frequency field. Data obtained showed that, at a relatively large distance between electrodes, the observed plasma stability may be explained by maintaining the criterion of stability for a maximum possible length of the deformation wave, while for small electrode distances the results of experiments involving the theory of dynamic stabilization are not in agreement. (tr-auth)

**46136** (IPP-1/81) TWO DIMENSIONAL THETA PINCH DYNAMICS WITH TRANSVERSE MAGNETIC FIELDS. Duechs, D. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1968. 73p. (In German). Dep.

The complete set of equations for the two fluid model of a fully ionized plasma, the parameters of which depend on two spatial dimensions and time, is solved by a computer program. This program is applied to the problem of plasma rotation in a theta pinch caused by transverse multipole fields. The results show that the plasma does not rotate like a cylindrical rigid body, rather the velocity varies strongly with azimuth. Moreover, the rotation is changing direction along the radius. Therefore transfer of angular momentum from outside is not necessary for the existence of rotation. Even in small transverse fields ($B \sim 500$ G) the rise time for the angular velocity is of the order of $10^{-7}$ sec and very short compared with those obtained from previous theoretical models. (auth)

**46137** (N-68-23191) MHD BOUNDARY LAYERS INVOLVING NONEQUILIBRIUM IONIZATION. Summary Report for Period Ending January 24, 1968. Sherman, A. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Feb. 24, 1968. Contract NASw-1586. 124p. (NASA-CR-94537). CFSTI.

The boundary layer in a plasma in which the electron and heavy particle temperatures may be different was studied. The problem is formulated from the viewpoint of multi-fluid magnetohydrodynamics (MHD). It differs from earlier treatments in that the complete electron energy equation is retained so that one must consider the plasma sheath in order to establish a boundary condition at the wall on the electron temperature. Initially a two-dimensional, laminar, steady flow is assumed. Also assumed are infinitely fast ionization and recombination rates so that the electron density can be calculated from the Saha equation at the electron temperature. Actual calculations were carried out along a channel wall partly insulator and partly thermionically emitting electrode. For the initial studies, restricted to a nonemitting insulator, the method of local similarity was used to solve the equations. All later studies used a finite difference scheme and the exact equations. The results demonstrate that the electron temperature can differ significantly from the heavy particle temperature and is very dependent on the magnetic field, thermionic emission, and current level. (auth) (STAR)

**46138** (N-68-23335) PLASMA CHARACTERISTICS OF THE ELECTRON BOMBARDMENT ION ENGINE. Masek, T. D. (Jet Propulsion Lab., Pasadena, Calif.). Apr. 15, 1968. Contract NAS7-100. 35p. (NASA-CR-94554; JPL-TR-32-1271). CFSTI.

An analytical study is presented as a first step in developing a model for engine operation. Solutions for the plasma potential distribution and the ion beam current are derived in terms of the electron and ion temperatures and densities. Experimental data, obtained with a Langmuir probe in mercury and cesium engines, are used to determine coefficients required in the plasma potential solutions. The use of these coefficients in the ion beam solution produced results consistent with Faraday probe measurements of the beam current. (auth) (STAR)

**46139** (N-68-23572) THE STUDY OF PLASMA-BOUNDARY INTERACTIONS. Quarterly Report, September 1-November 30, 1967. Aisenberg, S.; Hu, P.; Rohatgi, V.; Ziering, S. (Space Sciences, Inc., Waltham, Mass.). Contract NASw-1703. 29p. (NASA-CR-94579; SSI-455-QR-1). CFSTI.

Experiments were designed to measure the electrode drag forces in pulsed plasma accelerators and to extend the previous electrode drag measurements to higher arc currents (up to a thousand amperes). The Doppler shift technique was developed to determine the particle speed in the accelerated plasmas. A small wavelength shift of the order of 0.001 Å due to the motion of the radiating particle will be measured with an electrically modulated Fabry-Perot interferometer. To further understand the measured threshold in the electrode drag force, a physical model of threshold in momentum accommodation coefficient, depending on the melting point of surface atoms, was developed. (auth) (STAR)

**46140** (N-68-23989) BASIC PROCESSES OCCURRING IN GASEOUS PLASMAS IN VARIOUS CHARGE DENSITY AND ENERGY STATES. Final Report. Goldstein, Ladislas (Illinois Univ., Urbana. Gaseous Electronics Lab.). [1967]. 23p. (NASA-CR-72406). CFSTI.

This report reviews the work performed, suggests how the results of these studies can be applied to future projects, and lists the technical reports, theses, and scientific articles in which the results of these investigations have been published. (auth) (STAR)

**46141** (N-68-25551) FREQUENCY MULTIPLICATION IN HIGH-ENERGY ELECTRON BEAMS. Semiannual Progress Report, October 1, 1967-March 31, 1968. Getty, W. D.; Haddad, G. I.; Lomax, R. J.; Rowe, J. E. (Michigan Univ., Ann Arbor. Electron Physics Lab.). Apr. 1968. 20p. (NASA-CR-94680; SAPR-3). CFSTI.

The possibility of building a beam-plasma system which operates at a uniform pressure is investigated, and a study to determine the effect of collisions on the instability of a beam-plasma system is described. A time-dependent nonlinear analysis of the electron-beam-plasma interaction is discussed, along with an effort to develop a model which uses the dielectric constant to describe the nonlinear effect in the plasma. Instabilities in a magnetized plasma with an anisotropic velocity distribution were studied, the objective being to examine the feasibility of using this instability for electron cyclotron harmonic generation. Several methods of analyzing the nonlinear beam plasma and the two-stream interaction system using digital computer simulation techniques are also reported. Studies on the use of paramagnetic and semiductor materials to detect millimeter and submillimeter waves are included. (STAR)

**46142** (SU-IPR-244) NONLINEAR INTERACTION OF CYCLOTRON HARMONIC WAVES. Harker, K. J.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). June 1968. Contract AT(04-3)-326. 34p. Dep. CFSTI.

An analysis was made of nonlinear interaction between cyclotron harmonic waves propagating perpendicular to the static magnetic field in a warm magnetoplasma. It is demonstrated that the synchonism conditions for traveling-wave parametric amplification, and passive mode conversion can easily be satisfied for such waves, and an analysis is carried out for a large-signal pump wave interacting with two small-signal waves. The theory employs the Vlasov equation and Maxwell's equations, and provides expressions suitable for numerical computation. Growth rates and corresponding pump powers are computed, and it is concluded that the effect should be observable in typical laboratory plasmas. The paper concludes with a discussion of possible device applications. (auth)

**46143** (TID-24666, pp 76-82) NONLINEAR HARMONIC GENERATION AT PLASMA RESONANCES. Cohen, A. J. (Massachusetts Inst. of Tech., Cambridge).

The generation of harmonics of an rf signal applied to a monopole probe immersed in the center of a low-density ($n \sim 10^8$ electrons/cm$^3$), low-pressure ($p \sim 0.4$ $\mu$), dc discharge in argon is studied. Data were taken as follows: For fixed frequency f, the harmonic generation at 2f and 3f was observed as a function of discharge current. Then the incident frequency was varied and the measurements were repeated. Data runs were taken with the probe floating and biased slightly above and below floating potential. (M.O.W.)

**46144** (TID-24666, pp 96-102) INTERACTIONS OF A SPIRALING ELECTRON BEAM WITH A PLASMA. Kusse, B. R. (Massachusetts Inst. of Tech., Cambridge).

Recent experimental observations of the instability which results when the spiraling beam interacts with the plasma it produces are described. (M.O.W.)

**46145** (TID-24666, pp 103-5) OSCILLATIONS IN AN INHOMOGENEOUS COLD PLASMA. Schneider, H. M.; Bers, A. (Massachusetts Inst. of Tech., Cambridge).

General theoretical results are presented on the asymptotic time dependence of the voltage across the plasma. (M.O.W.)

**46146** (TID-24666, pp 145-56) STRONG TURBULENCE THEORY FOR A TRANSVERSE ELECTROMAGNETIC WAVE: COMPARISON WITH THE SINGLE-PARTICLE CALCULATION. Murakami, M.; Lidsky, L. M. (Massachusetts Inst. of Tech., Cambridge).

Dupree's strong turbulence theory is applied to wave-particle interaction in a transverse electromagnetic wave propagating parallel to an external magnetic field. By using a transformation of the velocity coordinate, which is essentially transformation to the wave frame used in studies of the single-particle motion, one reduces the Vlasov equation to a one-dimensional diffusion-type equation. Then, manipulation similar to that of the longitudinal wave case by Dupree leads to nonlinear wave-particle interaction, including trapped particle effects. The results in the strong field limit, where the trapping effect is important, are compared with results of the single-particle model. The results agree except for numerical factors. The single-particle calculation gives a proof of the correctness of the strong turbulence theory, which includes some crucial assumptions and provides some clearer physical intuitions. (M.O.W.)

**46147** PARTITION FUNCTIONS OF THE GROUND ELECTRONIC STATES OF $H_3^+$ AND $H_2^+$. Patch, R. W. (Lewis Research Center, Cleveland). J. Chem. Phys., 49: 961-2(July 15, 1968).

Internal partition functions of the ground electronic states of $H_3^+$ and $H_2^+$ in equilibrium hydrogen plasmas are presented graphically for temperatures up to 60,000°K. Calculations are described briefly. Details of the calculations and more extensive results are given by Patch and McBride in NASA Tech. Note D-4523 (1968). (A.G.W.)

**46148** ION STREAM INTERACTION WITH TARGET PLASMA DURING RECHARGING. Kartashev, K. B.; Pistunovich, V. I.; Filimonova, E. A. At. Energ. (USSR), 25: 95-100(1968). (In Russian).

The ion stream interaction with an isotopic cold plasma without magnetic field is examined. It is suggested, that the transverse and longitudinal temperatures of the ion stream are different. The anisotropy of ion temperature influence on plasma waves stability is determined (5 figures, 14 references). (auth)

**46149** METHOD OF DISPERSION OF PLASMA. De Barbieri, Oreste (Univ., Milan. CNR, Milan). Ric. Sci., 38: 102-8(Feb. 1968). (In Italian).

By means of the first two equations of BBGKY hierarchy, written to first order in the plasma parameter, the correlational contribution to the high-frequency branch of the plasma dispersion relation is evaluated. (auth)

**46150** INTERACTION OF ELECTROMAGNETIC RADIATION WITH A BOUNDED PLASMA. Melnyk, Andrew Rostyslaw. East Lansing, Mich., Michigan State Univ., 1967. 106p.

Thesis.

The interaction between electromagnetic waves and a bounded plasma is studied by extending the Fresnel equations of reflection and transmission to include plasma waves with irrotational electric fields. The properties of the plasma are incorporated in the dispersion relations for propagating waves. These dispersion relations are obtained from a frequency and complex wave vector dependent dielectric tensor $\underline{\epsilon}(\underline{k},\omega)$ calculated from a linearized Boltzmann transport equation. Results show structure in the absorptance, reflectance, and transmittance spectrum of thin plasma slabs ($d < 2\pi c/\omega_p$) due to resonance phenomena at frequencies where $kd = n\pi$; ($n = 1, 3, 5, \ldots$). These results suggest that the dispersion relations of metallic plasmas such as silver films may be optically measured. (Diss. Abstr.)

**46151** LONGITUDINAL PLASMA WAVE TRANSFORMATION INTO AN ELECTROMAGNETIC WAVE AT THE PLASMA–DIELECTRIC BOUNDARY. Fedorchenko, A. M. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 1032-4(June 1968). (In Russian).

The problem of plasma wave transformation into an electromagnetic wave was analyzed considering plasma wave angle of incidence to the boundary, reflection of transverse waves, electromagnetic waves, transverse waves, and electromagnetic waves polarized in the given plane. The ratio of the incident plasma wave intensity and the intensity of the electromagnetic wave was calculated in order to determine the efficiency of the transformation. (R.V.J.)

**46152** RADIATION INTO A PLASMA FROM A MAGNETIC LINE SOURCE ON A CONDUCTING PLANE. Ohkubo, Motoaki (Gunma Univ., Kiryu, Japan). Electron. Commun. Jap. (Engl. Transl.), 49: 118-19(Oct, 1966).

Expressions were derived for the radiation pattern inside the plasma region for a magnetic line current source in the surface of the conducting plane. The geometry of the problem is shown in which an insulating layer of air of thickness h is placed between the planar surfaces of the compressible plasma and the conducting plane. From the equations for $F_e(\theta)$ and $F_p(\theta)$, the radiated power patterns, respectively, for the electromagnetic wave (EM) mode and plasma wave (P) mode, a plot of values obtained for the range $\theta = 90°$ to 180° gave identical characteristics as for 0° to 90°. The results are evidently different from those previously published and indicate that the radiation pattern inside the plasma consists of two modes, EM and P. For $1 - (\omega_p^2/\omega^2) = 10^{-6}$, the EM mode becomes almost isotropic regardless of values of $k_0h$. In the P mode, while $k_0h$ is small, $\theta + 90°$, a slightly deviated direction from the z axis, it has the strongest radiation pattern. For $k_0h = 5$ near $\theta =$ 17.5 and 71°, there exist extremely strong directivities which are drastically different results from the case of small values of $k_0h$. The peak value of the radiation characteristics increases as the value of $k_0h$ increases. It was concluded that the radiation characteristics in a compressible plasma are strongly influenced by the thickness of the insulating air layer. (BBB)

**46153** INTERACTION OF INTENSE MICROWAVE FIELDS WITH INITIALLY HEATED AIR. Mayhan, Joseph Thomas. Columbus, Ohio, Ohio State Univ., 1967. 168p.

Thesis.

A model governing the propagation of a short-duration intense electromagnetic field in initially heated air is described and applied to predicting the nonlinear breakdown of a shock-induced plasma. Certain kinetic processes involving $N_2$, NO, and O for 4000 to 5000°K air are examined in order to determine the nonlinear response of the field transmitted through the plasma. Evolution of the electron temperature throughout the plasma is specified upon incorporating these kinetic processes. It is found that the maximum electron temperature increase is inhibited by inelastic energy losses in exciting $N_2$ and ionizing NO. Ionization rates of initially heated air at 4500°K are presented and found to be substantially greater than room temperature ionization rates and ionization rates in the 3000 to 4000°K range. The problem is basically nonlinear since a fraction of the electromagnetic energy deposited into the plasma goes into creating more electrons due to electron–neutral ionizing collisions. The pulse is assumed short enough so that diffusion can be neglected and dissociative recombination of $NO^+$ is assumed to be the dominant electron loss mechanism. Both initially homogeneous and inhomogeneous electron distributions are considered, the latter demonstrating the effect of the boundary layers adjacent to the plasma containing walls. The incident pulse rise time is shown to be significant in determining the ionization rate when the initial plasma electron density is near the plasma resonant density. Further the pulse rise time has a significant effect on the peak signal height transmitted. (Diss. Abstr.)

**46154** ECHO PHENOMENA IN A HIGHLY IONIZED PLASMA. Judd, O'Dean Paul. Los Angeles, Univ. of California, 1968. 141p.

Thesis.

This dissertation relates the results of a theoretical and experimental investigation of cyclotron echo phenomena in a highly ionized plasma. In such a plasma the collisional mechanisms are exclusively Coulombic which enables one to formulate the theory in an exact analytical sense and thereby provide a basis for quantitative comparison with the experimental observations. The published theory to date of two pulse cyclotron echoes in a plasma relies on an external magnetic field inhomogeneity to provide the necessary distribution of oscillators in the plasma. This theory is reviewed in detail and modified to provide a general formulation for the case of Coulomb collisions. The theory is then extended to point out the possibility of echo generation by a single pulse excitation. Echo phenomenon is discussed in a generalized sense, and the possible oscillator distributions produced by plasma effects alone are enumerated. The collective and Doppler effects in the plasma are investigated in detail and shown to produce echoes even though the magnetic field is perfectly uniform. The effects of particle diffusion in the plasma are shown to modify the theoretical echo behavior considerably in some echo processes. The experiments were performed in a highly ionized (90%), steady-state, Maxwellian plasma column generated in a Q device. The plasma density $n_0$ could be varied over the range $10^{10} \leq n_0 \leq 10^{12}$/cm$^3$ and the radial magnetic field homogeneity could be varied from 0.001 to 2%. The frequency of the incident pulses of microwave radiation ranges from 8 to 10 Gc. Experimentally it was observed that the echo could be excited by the conventional two pulse technique (2p) or by excitation with a single pulse of long duration (1p). In both the 2p and 1p echoes the frequency of the incident microwave radiation, the cyclotron frequency, and the frequency of the echo radiation were all within 1%; this result was independent of density and magnetic field. The echo linewidth was observed to be a relatively weak function of the magnetic field homogeneity and to exhibit anomalous behavior in very uniform fields; in particular, echoes with temporal linewidths of 10 nsec were observed which broadened as the pulse separation increased. Over a narrow range of parameters, a structure in the echo envelope was observed. A definite phase relation of 180° between consecutive echoes was observed for a given range of parameters. Comparison of the experimental results with the established theoretical model indicated that the alternate models provide a more satisfactory explanation for the observations. (Disser. Abstr.)

**46155** RECOMBINATION IN LOW TEMPERATURE HELIUM PLASMAS. Kaplafka, James Peter. Urbana, Ill., Univ. of Illinois, 1967. 93p.

Thesis.

Plasmas produced in pure helium gas at atomic densities ~$10^{13}$ to $10^{15}$/cc were studied. Qualitative observations were made at a gas temperature of 4.2°K while most quantitative results were obtained at a gas temperature of 77°K at a pressure of 9.5 torr in a region of free electron densities $10^9$ to $10^{11}$/cc. Molecular band radiations from n = 4-2 and 3-2 transitions of the $He_2$ molecule were found to be the sole prominent contributions to the visible afterglow light intensity for times beyond ~400 μsec of the afterglow. Measurements of free electron density, $n_e$, and total "effective" electron collision frequency for momentum transfer, $\nu_{eff}$, were made with a low-power sensing microwave signal transmitted through the afterglow plasma. The measured values of $\nu_{eff}$ were interpreted to give the temperatures of the free electron gas, $T_e$. The afterglow plasma was disturbed by application of a second somewhat higher power microwave pulse capable of increasing $T_e$. In addition to increasing $T_e$, application of the microwave heating pulse was found to result in an increase of $n_e$ apparently by means of collisions of free electrons with certain neutral states. The surprising feature of this production was its appearance at values of $T_e$ representing mean electron energies much much smaller than the ionization energies of the He atomic ground state or metastable states or the $2^3\Sigma_u^+$ metastable state of $He_2$. As a point of reference, raising $T_e$ from ~150 to 300°K may increase an $n_e$ of $10^9$/cc by 50%. Light intensities in the visible show a large momentary increase (so-called "afterpulse") upon rapid removal of microwave heating which is interpreted to be the result of recombination enhanced by the increase of $n_e$ during heating. Rapid decay (tens of μsecs @ $T_g$ = 77°K) of the light intensity, after the peak of the afterpulse, to the normal afterglow level accompanies a measured rapid decay of $n_e$ back to normal following removal of microwave heating. This return to normal is thought to result from reestablishment of a normal population of highly excited electronic states in an approximate collisional equilibrium with the free electron gas in the normal afterglow. Total (spectrally unresolved) visible light intensity was found proportional to $n_e^2$ for afterglow times >~2 msec ($n_e \approx 10^8$ to $10^9$/cc). From the behavior of total visible light intensity upon application and upon removal of microwave heating the electron-ion recombination coefficient, $\alpha$, is interpreted to be proportional to $T_e^{-(1\cdot1-1\cdot2)}$. (Disser. Abstr.)

**46156** GENERALIZED STOCHASTIC EQUATIONS AND THEIR APPLICATIONS TO PLASMAS. So, Kam-chuen. Urbana, Ill., Univ. of Illinois, 1967. 99p.

Thesis.

The Fokker–Planck equation has often been used to describe the distribution of a particle in a random field. When such a technique is applied to a plasma in order to obtain a kinetic equation, certain difficulties arise. In the first place, the electric field must be determined consistently and the coefficients cannot be found explicitly without further assumptions which may not be consistent. Previously various attempts have been made to find the coefficients including the use of the collision concept by means of the Boltzmann equation and the BBGKY theory. In certain

cases, this amounts to a manipulation of a kinetic equation into the form of a Fokker–Planck equation. Moreover, the coefficients are given as averages of functionals of the random field. A naive interpretation of these averages, however, gives incorrect results. In view of these difficulties, a new formulation of the Fokker–Planck method is established. It is observed that the coefficients actually involve conditional averages of functionals of the random field. Furthermore, just as a Fokker–Planck equation can be used to describe the lowest distribution, similar equations can also be used to describe higher distributions. Such a set of equations is called generalized stochastic (or generalized Fokker–Planck) equations following Stratonovich. These equations are applicable to systems perturbed by small random forces provided sufficient knowledge regarding the unperturbed system is available. When the random forces are specified statistically, the generalized stochastic equations give immediate results. In this respect, of particular interest in plasma application, is the heating of electrons by random electric fields. For the Coulomb potential problem in which the electric field has to be determined consistently, it is possible to decouple the set of generalized equations by using a cluster expansion. The coefficients can then be found explicitly resulting in a kinetic equation. The results indicate that the use of a Vlasov equation in finding the polarization effect is essentially justified. The polarization effect is seen to be the consequence of the condition imposed on the average in evaluating the coefficient. Unlike the test particle theory, however, no test particle is artificially introduced. Finally, a similarity is observed between the set of generalized stochastic equations and the BBGKY hierarchy. Closer examination reveals that the BBGKY hierarchy may be regarded, in a sense, as a special mode of generalized stochastic equations. (Disser. Abstr.)

**46157** STABILITY PROBLEMS IN PLASMA KINETIC THEORY. Krueger, Jan (Univ., Ghent). Verh. Kon. Vlaam. Acad. Wetensch. Belg. Kl. Wetensch., 29: 7-95(1967). (In Dutch).

The solutions of the equation of force-free fields with constant $\alpha$ (scalar function of position) are reviewed. A new derivation ensures one that the solutions are the most general ones. The stability of force-free fields with constant $\alpha$, surrounded by a rigid wall, is investigated. The analysis is based on the energy-principle of Bernstein et al., according to which the system is stable if and only if the second-order variation of the energy is positive definite for arbitrary perturbations $\xi$. An energy principle is presented (in the frame of the magnetodynamic approximation) which is the unification of the well known energy principle for gravitational (Chandrasekhar) and magnetodynamic stability (Bernstein et al.). The general formalism was then applied to force-free fields. The pressure is now balanced by the gravitational forces and surface currents. (M.O.W.)

**46158** FIZICHESKIE PROTSESSY V ELEKTROMAGNITNYKH UDARNYKH TRUBAKH. (Physical Processes in Electromagnetic Shock Tubes). Makarov, Yu. V.; Chekalin, E. K. Moscow, Atomizdat, 1968. 268p.

Experimental data are presented on the physical properties of plasma behind strong shock waves produced by strong pulse discharges. Physical properties of plasma at high temperatures, structure of the front luminescence in electromagnetic shock tubes, the state of gas behind the shock wave, and properties of plasma near the discharge chamber and magnetic fields in plasma are discussed in the first four chapters. The last two chapters deal with the concepts and possibilities of expanding the use of electromagnetic shock tubes in experimental studies. 243 references are included. (R.V.J.)

**46159** ELECTROMAGNETIC WAVES IN MOVING MAGNETOPLASMAS. Chawla, Basant Ram. Lawrence, Kan., Univ. of Kansas, 1967. 215p.

Thesis.

Theoretical aspects of electromagnetic wave propagation in moving plasmas are considered. They are: characteristic equations for waves propagating in arbitrary direction in temperate and warm plasmas moving uniformly at an arbitrary angle to a uniform static magnetic field, radiation from electromagnetic sources in the presence of a uniformly moving temperate magnetoplasma, normal and oblique incidence of linearly polarized plane electromagnetic waves on a semi-infinite or slab of temperate or warm magnetoplasma moving through free space or a dielectric medium, radiation from an electric dipole in the presence of a moving dielectric half-space, Poynting vector in moving plasmas, and wave propagation in a two stream magnetoplasma. (TSS) (Diss. Abstr.)

**46160** SOME OBSERVATIONS OF THE ACCELERATION IN A COAXIAL PLASMA GUN. Pert, G. J. (Imperial Coll. of Science and Tech., London). J. Appl. Phys., 39: 4215-18(Aug. 1968).

The current distribution in the plasma behind the luminous front is investigated by means of magnetic probes. It is found that a standing arc is established at the insulator backplate later in the discharge, which effectively crowbars the current in the gun. The motion of the front under these conditions is compared with the model due to Fishman–Petschek. (auth)

**46161** EXPERIMENTAL INVESTIGATION OF THE LOW-VOLTAGE ARC IN NOBLE GASES. Martin, R. J.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 39: 4289-98 (Aug. 1968).

An experimental investigation of the low-voltage arc mode of the hot-cathode discharge was carried out in a diode utilizing planar electrode geometry. The investigation consisted predominantly of Langmuir-probe measurements of the discharge in a neon atmosphere. Measurements were also obtained in argon, xenon, and hydrogen and hydrogen–neon and argon–neon mixtures. The probes were of planar, guard-ringed geometry. The volt–ampere characteristic of the hot-cathode discharge in the Torr range of gas pressure was investigated to further define the low-voltage arc. For ample emission at the cathode there are two stable high-current, low-voltage discharge modes that occur in the noble gases; these are termed the low-voltage arc and the ball-of-fire modes of the hot-cathode discharge. No low-voltage discharge modes were obtained in hydrogen. The steady-state characteristics obtained for the low-voltage arc indicated peak plasma potentials of approximately 14, 6, and 4.5 V for neon, argon, and xenon, respectively, considerably lower than the first excitation level of the respective gases. There is a minimum value of the product of pressure and electrode spacing for the existence of the low-voltage arc; this condition also yields a minimum value of discharge voltage. The discharge voltage and peak electron densities increase with increasing pressure-spacing product, while the peak plasma potential decreases gradually. Measurements on the discharge in neon atmospheres containing small admixtures of hydrogen indicated that cumulative ionization is important for the generation of the low-voltage arc. It was not possible to detect in the measurements on pure noble gas experimental atmospheres any effects due to the presence of impurities. The study of the Penning impurity effect in the low-voltage arc was limited, but showed that mixtures of less than 0.06% argon in neon do affect the discharge. (auth)

**46162** INTERACTION OF ELECTROMAGNETIC WAVES WITH CYLINDRICAL PLASMA. Gal, George (AVCO Space Systems Div., Wilmington, Mass.); Gibson, Walter E. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 468-75(July 1968).

Exact numerical solutions are given for the interaction of a plane, electromagnetic wave with a cylindrical plasma. The incident wave is normal to the plasma axis and both TE and TM polarizations are considered. The electron density profile is represented by a Gaussian curve consistent with flow-field calculations for wakes and jets. Transmitted and scattered amplitudes are evaluated as functions of the polar angle and plasma parameters. The data are compared with previous theoretical and experimental work. Parabolic electron density profiles are also investigated and contrasted with the Gaussian results. The sharp cutoff in a parabolic profile has a significant effect on the electromagnetic interaction. Applications to microwave diagnostics are discussed including a new bistatic method. (auth)

**46163** SPONTANEOUS EXCITATION OF MAGNETIC FIELDS IN TURBULENT PLASMA. Tsytovich, V. N. (Leningrad Inst. of Physics). Dokl. Akad. Nauk SSSR, 181: 60-3(July-Aug. 1968). (In Russian).

Spontaneous magnetic field excitation in a conducting turbulent fluid (or a condition in which the turbulent conducting fluid is unstable in relation to the developed magnetic field excitations) was studied previously and it was shown that the magnetic field energy was derived from hydrodynamic turbulent fluid pulsations. An attempt is made here to show that such spontaneous excitation of the magnetic field is possible in a turbulent plasma and a general method is given for studying problems of turbulent plasma instabilities. (R.V.J.)

**46164** KINETIC EQUATION FOR AN INHOMOGENEOUS PLASMA IN A MAGNETIC FIELD. De Barbieri, O. (Univ., Milan. GNEQP, Milan); Montaldi, E.; Guernsey, R. L. Ann. Phys. (N. Y.), 48: 221-36(June 2, 1968).

A fully ionized many-species plasma in quasi equilibrium is considered. The effect of a magnetic field on the functional dependence of the linearized two-particle correlation function on the linearized one-particle distribution function is explicity evaluated. A dispersion relation is obtained that takes into account the effect of the correlations. (auth)

**46165** STRESS TENSOR FOR A PLASMA IN A HIGH-FREQUENCY ELECTROMAGNETIC FIELD WITH ACCOUNT OF

COLLISIONS. Perel, V. I.; Pinskii, Ya. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 54: 1889-98(June 1968). (In Russian).

The time-average stress tensor for a plasma in a high-frequency electromagnetic field is obtained. The initial equations are the kinetic equations in which collisions are taken into account. Weakly ionized and totally ionized plasmas are considered. It is shown that the stress tensor significantly depends on the nature of the collisions and cannot be expressed in terms of the dielectric permeability. (auth)

**46166** OSCILLATIONS OF PLASMA IN ELECTRIC AND MAGNETIC FIELDS. Gordeev, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 787-95(May 1968). (In Russian).

The results of the dispersion equation of the linear oscillation of electron–ion and electron-hole plasma, occurring at the exterior of constant electric and magnetic fields are given. The longitudinal waves of the electron–ion plasma are investigated. It is shown that in strong magnetic fields the excitation increment of the low-frequency oscillation of the plasma has an absolute maximum at nodes of the interperpendicular spacing of the electric and magnetic fields together with a relative maximum in their parallel spacing. (tr-auth)

**46167** HARD X RAYS EMITTED FROM THE $\theta$ PINCH. Sato, Kazuo; Ohnishi, Haruyuki (Nihon Univ., Tokyo). Kakuyugo-Kenkyu, 21: 121-49(Aug. 1968). (In Japanese).

Hard x rays emitted from the slow $\theta$ pinch were measured in order to clarify the acceleration mechanism of high-energy electrons in the rising axially magnetic field. The conditions for the hard x-ray emission were studied by varying the initial gas pressure, charging voltage, and the capacity of condenser bank, or by using the various kinds of gases. There are some evidences that the electron acceleration is not due to the single-particle induction mechanism. It was found that the hard x rays were mostly emitted from the central volume of the discharge tube rather than from the wall of the tube. (auth)

**46168** INTERACTION OF THE CHARGED-PARTICLE BEAMS WITH SURFACE WAVES IN THE PLASMA. Pakhomov, V. I.; Stepanov, K. N. (Physico-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 796-805(May 1968). (In Russian).

The interaction of surface waves, being propagated along the plane gradient of the plasma, with electron beams of low density, moving outside the plasma parallel to its gradient, was investigated. The growth increments in the case of coherent excitation of the surface wave of the monoenergetic electron beams, and in the case of the excitation of the wave with resonance particles of the beam with wide dispersion of the electrons with velocity, are obtained. The possibility of using a beam of strongly relativistic electrons for generation and intensification of the surface wave with frequencies in the millimeter and submillimeter region is considered. (tr-auth)

**46169** ELECTRON VISCOSITY COEFFICIENTS OF LOW-TURBULENCE PLASMA. Baimbetov, F. B. (Tbilisi State Univ., USSR). Zh. Tekh. Fiz., 38: 806-8(May 1968). (In Russian).

The electron viscosity coefficients of low-turbulence plasma, occurring in strong magnetic fields, were determined. It is shown that the turbulence substantially affects the phenomenon of viscosity, although its effect on the viscosity is much less than on the other transfer phenomena. (tr-auth)

**46170** NONLINEAR THEORY OF HYDRODYNAMIC BEAM INSTABILITIES. I. Makhan'kov, V. G.; Tsytovich, V. N. Zh. Tekh. Fiz., 38: 809-11(May 1968). (In Russian).

An evaluation was made of the fraction of the energy lost by the beam during the development of aperiodic beam instabilities up to its collapse. In the case of a rarefied beam, when its density is significantly less than the density of the plasma, the energy fraction is relatively small. (tr-auth)

**46171** CONFIGURATIONS OF HIGH PRESSURE ELECTRODELESS DISCHARGES. Pryadkin, K. K.; Mitin, R. V. (Physico-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 823-9(May 1968). (In Russian).

Electrodeless discharges in inert gases at pressures exceeding atmospheric, and the effect of such discharges of stationary magnetic fields, were investigated. Tests undertaken to clarify the nature of the magnetic properties of hf discharges were described. The possibility of the simultaneous existence in the discharge chamber of two plasma bunches is shown, as well as the production of bunches with large linear dimensions. A description is given of the spatial-periodic structure of the plasma, arising in electrodeless high-pressure E discharges. (tr-auth)

**46172** DEVELOPMENT OF DISCHARGES IN THE NON-CYLINDRICAL Z PINCH. Kolesnikov, Yu. A. Zh. Tekh. Fiz., 38: 833-42(May 1968). (In Russian).

The initial stages of the development of the discharge in non-cylindrical Z pinch were studied experimentally and theoretically. In the calculation of the processes of formation and motion of such layers in the determination of the conductivity, both Coulomb collisions and collisions of electrons with neutral atoms were taken into consideration. It was shown that the breakaway of such layers from the surface of the insulator occurs at once at the moment of puncture. The conditions of opacity of such layers for neutral atoms were determined. The dynamics of the plasma film, moving from the insulator to the side walls of the chamber, were determined. It was established that at the moment of the achievement of the condition of opacity its motion is described by the snowplow model. (tr-auth)

**46173** INSTABILITY OF BEAM-PLASMA DISCHARGE AT LOW PRESSURE IN THE MAGNETIC TRAP. Marinin, V. G. Zh. Tekh. Fiz., 38: 843-5(May 1968). (In Russian).

The interaction of the electron beam with the plasma, created by this same beam at gas pressures in the chamber of $1 \times 10^{-5}$ to $6 \times 10^{-5}$ mm Hg, was investigated. The energy of the beam was varied from 0.2 to 5 kV and the current was 0.1 A. The existence of two regimes, in which the plasma–beam system can occur, was established. The plasma parameters in these regimes were substantially different. The transition of the system from one regime to the other depends on the magnetic fields, gas pressure, and the voltage accelerating the electron beam. The transition, obviously, is connected with the electric fields, arising in the system. During transition of the plasma–beam system to the second regime, strong low-frequency oscillations originate. (tr-auth)

**46174** ENERGY BALANCE OF A STABILIZED ARC IN ARGON WITH INTENSE AXIAL FLOW OF THE GAS. Baturin, V. A.; Ulanov, I. M. Zh. Tekh. Fiz., 38: 888-92(May 1968). (In Russian).

The energy balance of an arc, burning in cylindrical channels (cooled quartz tubes, copper plates) during axial flow of the gas, was investigated. With constant value of the current (100, 125, and 150 amp), the general output of the thermal partitions in the wall and on the electrodes, the energy loss of the gas flux from arc boundary, and the irradiation yield in dependence on the argon consumption (0.02 to 3 g/sec) were determined. The energy loss with the gas flow to a strong degree depends on the consumption and attains 65% of the arc output. The irradiation yield per unit length of the column is 15 to 20% of the energy input. (tr-auth)

**46175** EFFECT OF A VERY-HIGH-FREQUENCY FIELD ON THE PLASMA CHARACTERISTICS OF THE NEGATIVE GLOW OF A GLOW DISCHARGE IN HELIUM. Solntsev, G. S.; Orlov, A. I.; Gerasimov, N. Ts. Zh. Tekh. Fiz., 38: 893-6(May 1968). (In Russian).

The distribution functions of electrons with energy in the negative glow of a glow discharge in helium were investigated at pressure of 1-mm Hg and current of 400 to 800 $\mu$A. The output of the vhf oscillation of 2400 MHz changes from 1 to 20 W. It was established that the irradiation with the vhf field leads to the deformation of the distribution function of the electrons so that the mean energy decreases and the comparative number of fast electrons in the plasma is reduced. The concentration of the electrons during this is reduced which quantitatively can be explained by the variation of the condition for the gas ionization and the diffusion loss. (tr-auth)

**46176** THEORY OF LOW-VOLTAGE ARCS IN SHORT GAS GAPS. Nastoyashchii, A. F. Zh. Tekh. Fiz., 38: 902-13(May 1968). (In Russian).

The theory of the low-voltage arc in narrow inter-electrode gap was proposed. It was assumed that the transfer of current and gas ionization in the discharge is accomplished by a current of fast electrons, accelerated by the cathode barrier. The space–energy distribution of the fast electrons in the gap was determined. Some simple relations, describing the ionization state of the gas gap, were obtained. The case of low-voltage arcs in Cs vapor was considered in detail. The ionization and recombination processes in cesium plasma were described on the basis of some three-level models of Cs. Formulas for the degree of ionization of the gas in the discharge were formulated, which are the generalization of the Saha formulas in the case of plasma with clusters. The results of the approximate calculations of the discharge in Cs vapor were reported. (tr-auth)

**46177** EXPERIMENTAL VERIFICATION OF THE EXISTENCE OF CLOSED PARTICLES IN TOKAMAK PLASMA. Petrov, M. P. (Ioffe Physical-Technical Inst., Leningrad). Zh. Tekh. Fiz., 38: 938-41(May 1968). (In Russian).

The measurement of the distribution of the beam of fast overcharged atoms, emitted by the plasma, across the plasma tube

in the Tokamak installation was described. The asymmetry of the beam distribution with respect to the plasma axis was determined. It was shown that this effect can be connected with the existence of closed ions with energy of several hundred eV in the plasma of the Tokamak installation. (tr-auth)

**46178** STATISTICAL MECHANICS OF A PARTIALLY IONIZED PLASMA. Jackson, Julius L.; Klein, Lewis S. (Howard Univ., Washington, D. C.). pp 275-83 of Statistical Mechanics: Foundations and Applications. Proceedings of the I.U.P.A.P. Meeting, Copenhagen, 1966. Bak, Thor A. (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-660727.

The calculation of the equilibrium composition of a partially ionized plasma is discussed. A consistent treatment is presented of the problem in a particular approximation, wherein the atom–plasma interaction is handled in the Debye–Hueckel approximation. (M.O.W.)

**46179** ELECTRICAL CONDUCTIVITY OF A HIGHLY TURBULENT PLASMA. Hamberger, S. M.; Friedman, M. (United Kingdom Atomic Energy Authority, Berkshire, Eng.). Phys. Rev. Lett., 21: 674-7(Sept. 2, 1968).

The electric conductivity of a highly turbulent plasma is measured in the electron density range $10^{10}$ to $10^{13}$ $cm^{-3}$, using hydrogen, argon, and xenon. When the applied electric field is large ($\gtrsim$100 V $cm^{-1}$), it is found that the conductivity may be described by the formula $\sigma \approx \frac{1}{2}(M/m)^{\frac{1}{2}}\omega_{pe}$ first suggested by Buneman. (auth)

## Production of Plasma

*Refer also to abstract 45213.*

**46180** (WERL-3472-11) PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Quarterly Progress Report No. 2, May 1, 1968–July 31, 1968. Engelhardt, A. G. (Westinghouse Research Labs., Pittsburgh, Pa.). Aug. 1, 1968. Contract AT(30-1)-3472. 5p. Dep. CFSTI.

During this period, Thomson scattering measurements of electron temperature and density were continued. The multichannel photomultiplier detection system was almost completed. Theoretical work was concerned with an evaluation of the thermokinetic theory. Brief descriptions of research progress on each are given. (M.O.W.)

**46181** SHOCK WAVES WITH STRONG IONIZING ACTION IN HYDROGEN AND NITROGEN. Pietrzyk, Z. A. (Instytut Postawowych Problemow Techniki, Warsaw). Arch. Mech. Stosow., 18: 259-72(1966).

The Hugoniot-Rankine conditions are developed and the gas parameters behind the shock wave are determined. Values of the pressure before the shock wave are those usually applied in laboratories (from 0.01 to 0.5 mm Hg) at speeds necessitating consideration of the radiation. The computation was performed in 2 variants, either taking or not taking into consideration the influence of radiation. Computation indicated that for very strong shock waves the influence of the radiation should be taken into consideration with the Hugoniot-Rankine conditions, for U > 32 km/sec for hydrogen and for U > 70 km/sec for nitrogen for pressures before the shock wave. The influence of Coulomb interaction of particles can be disregarded for small gas densities. For thermodynamic equilibrium between the photons and the medium, values of the gas parameters behind the shock differ considerably from the results obtained without taking into consideration the radiation, at least for small initial densities and high shock velocities. The density ratio across a shock, whose velocity tends to infinity, tends to 7 (not 4). The temperature for such a shock is $T \cong U^{\frac{1}{2}}$ (not $T_2 \cong U^2$). An appendix describes computation of gas parameters for variable degree of ionization. (BBB)

**46182** INSULATED WALL POTENTIAL STABILIZATION MODES IN GAS DISCHARGES. Bacal, Martha; Cristescu, Maria (Inst. for Atomic Physics, Bucharest). Z. Phys., 213: 171-84(1968).

Arguments for demonstrating the contribution of the ion current in the process of wall potential stabilization at a positive value and the results of some experiments supporting this viewpoint are presented. It is also shown that the variation in gas pressure leads to a change in the number of possible stabilization modes. It is argued that the values of the stable wall potentials are determined by the secondary emission properties of the wall surface, the tube configuration and the values of the charged particle fluxes to the wall. The wall-cathode and wall-anode capacitances may influence only the direction in which the wall potential will drift during the stabilization process, in the case when two stable values of the wall potential exist. (auth)

**46183** SHOCK-WAVE GENERATION IN RAREFIED GASES BY LASER IMPACT ON BERYLLIUM TARGETS. Bobin, J. L.; Durand, Y. A.; Langer, Ph. P.; Tonon, G. (Commissariat a l'Energie Atomique, Villeneuve-Saint-Georges, France). J. Appl. Phys., 39: 4184-9(Aug. 1968).

Shock waves in argon and in air have been observed when focusing a 0.8-J, 40-nsec, Q-switched ruby laser beam onto a beryllium target in the presence of gas at various pressures ranging from $2 \times 10^{-1}$ to 3 Torr. High-speed streak and framing camera as well as a prism spectrograph have been used as diagnostic tools. Space-resolved spectra show, besides an intense continuum, Stark-broadened lines from Be I and Be II. The reinforced argon lines when moving off the Be target surface are probably due to a shock wave driven by the Be plasma acting as a piston. A simple theoretical model taking this mechanism into account is proposed. Calculated curves for the outer radius variations of the shock front fit closely the experimental results. (auth)

**46184** FILM-COOLING OF A PLASMA GENERATOR ANODE. Cremers, Clifford J. (Univ. of Kentucky, Lexington); Shiver, Warren D.; Birkebak, Richard C. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 1774-6(Sept. 1968).

Detailed experiments have been carried out to determine the operating characteristics of an argon plasma generator that has an anode fully protected by film cooling. In order that the results be comparable with those from a more common type of plasma generator, an interchangeable water-cooled anode section was run also with most of the same test parameters. Comparisons are made concerning the relative merits of the two devices, and this allows some inferences to be drawn regarding the various modes of energy transfer at the anode surface. (M.O.W.)

**46185** NONLINEAR ION-ACOUSTIC WAVES IN A PLASMA. Alikhanov, S. G.; Belan, V. G.; Sagdeev, R. Z. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.), 7: 318-19(June 5, 1968).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 7: 405-8(June 5, 1968).

An experiment was conducted in which an initially smooth disturbance of large amplitude in a nonisothermal plasma disintegrates from nonlinear deformation into elementary oscillations of wavelength on the order of the Debye radius. The plasma was produced from rare gas by ionization from an incandescent cathode, and the disturbance wave was produced by a cylinder of grids with a positive potential. Oscillograms of the signals from a plasma absorber show that the wave propagation is accompanied by a decrease in the width of the front down to ~2 cm (Debye radius). The front of the wave is plane to within 1 cm. (D.L.C.)

**46186** THERMOELECTRON EMISSION AND DIVERGENCE OF THE PLASMA FORMED UNDER THE EFFECTS OF A FOCUSED MONOPULSED LASER BEAM ON A SOLID TARGET. Andreev, S. I.; Dymshits, Yu. I.; Kaporskii, L. N.; Musatova, G. S. Zh. Tekh. Fiz., 38: 875-83(May 1968). (In Russian).

A study was made of the electron emission from plasma arising under the effects of the radiation of the monopulse OKG on a metallic target, existing in a vacuum, and of the velocity of the jet propagation. By means of the emission equation in the presence of space charge, a method is proposed for the determination of the temperature. It is shown that the density distribution in the jet must be abruptly irregular. With consideration of this irregularity, the expression for the plasma temperature, determined by the divergence rate of its peripheral layer, is obtained. (tr-auth)

## Stability of Plasma

**46187** (IAE-1444) SUPPRESSION OF PLASMA FLUTE INSTABILITY BY MEANS OF FEEDBACKS. Arsenin, V. V.; Chuyanov, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 24p. (In Russian). Dep.

A brief review is given of the theory and experiments on suppressing flute instabilities in a trap with injection of fast neutral Ogra II atoms by means of a feedback system, measuring low-frequency electric fields and controlling potentials of certain elements of the vacuum chamber surface. Data obtained indicate that the suggested stabilization system is in good control of the plasma stability. (tr-auth)

**46188** (IAE-1490) POSSIBILITY OF USING SUPERHIGH-FREQUENCY FIELDS FOR STABILIZING CONVECTIVE PLASMA INSTABILITIES. Glagolev, V. M.; Khromkov, I. N.; Cheverev, N. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1968. 23p. (In Russian). Dep.

Experimental studies were made of volume resonator super-

high-frequency ($\omega \sim 2 \times 10^{10}$ sec$^{-1}$) field interactions with plasma ($n \simeq 10^{13} + 10^{14}$ cm$^{-3}$) in a constant magnetic field. Under the influence of the super-high-frequency field a flow of paramagnetic current was observed on the plasma surface; the resulting increase of the static magnetic field inside the plasma was in agreement with theoretical calculations. At $\omega_H/\omega = 0.5$, electron paramagnetic resonance revealed a rapid growth of plasma pressure $p_\theta$ up to $\beta_\theta = 8\pi p_\theta/H_z^2 \simeq 0.2$. The possibility of using the paramagnetic effect for stabilizing convective plasma instability is discussed at length. (tr-auth)

**46189** (LA-DC-9324) LINEAR $\theta$-PINCH EXPERIMENTS RELATED TO THE STABILITY OF A TOROIDAL $\theta$-PINCH OF LARGE ASPECT RATIO. Little, E. M.; Newton, A. A.; Quinn, W. E.; Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 15p. (CONF-680805-20). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

In a high-$\beta$, toroidal $\theta$ pinch (compression field $B_e$) the outward radial force ($\simeq \beta B_e^2 a^2/4R$) due to the major curvature 1/R can be neutralized by introducing radial excursions $a\delta_1 \cos l\theta \cos kz$ about the minor radius a of the plasma surface. Owing to the periodic regions of unfavorable curvature and to the high $\beta$ ($\simeq 0.8$ on axis), the equilibrium is grossly unstable to Haas–Wesson modes of the form $\xi_m(z) \cos m\theta$. Results are reported here of experiments on one-meter $\theta$-pinch plasmas with adiabatically applied l = 0 bumps both for hot-ion ($kT_i \simeq 2$ keV) and cold-ion plasmas with maximum densities n in the range from $5 \times 10^{16}$ to $1 \times 10^{17}$ cm$^{-3}$. Plasma properties $\beta$, $k(T_i + T_e)$, n, and the instability growth rates are established for known $B_e$ by means of: (a) Faraday rotation measurements of the internal magnetic field; (b) Mach–Zehnder interferometer measurements of the density and plasma shape; and (c) streak-camera measurements of radial plasma motion. For $0.11 \leq \Delta B_e/B_e \leq 0.22$ only the m = 1 mode is observed, and its magnitude is reduced in the hot-ion cases (where end loss is also larger). Small initial negative bias fields $B_\theta$ are shown to enhance the m = 1 instability. With quasi-static longitudinal currents $I_z \leq 50$ kA the Kruskal–Shafranov modes are identified and their growth rates measured. The resistance of the current-carrying channel is determined and interpreted when $I_z$ is alternated at frequencies of 0.6–0.8 MHz. No effect of $I_z$ on the plasma density distribution about its axis is seen. (auth)

**46190** (MATT-617) LOW FREQUENCY STABILITY OF AXISYMMETRIC TORUSES. Rutherford, P.; Rosenbluth, M.; Horton, W.; Frieman, E.; Coppi, B. (Princeton Univ., N. J. Plasma Physics Lab.). July 1968. Contract AT(30-1)-1238. 23p. (CONF-680805-17). Dep. CFSTI.

From 3rd International Conference on Controlled and Plasma Physics, Novosibirsk, USSR.

The low frequency stability of low-$\beta$, collisionless plasma in axisymmetric toroidal configurations such as multipoles with and without applied toroidal fields is studied in some detail. Defining the "bounce" frequency $\omega_b = (\int dl/v_\parallel)^{-1}$ modes are investigated with $\omega > \omega_{be}$, $\omega_{bi} < \omega < \omega_{be}$, and $\omega < \omega_{bi}$. Three classes are found: (1) flute modes, (2) ballooning and drift modes, and (3) trapped particle modes. Stability of the flutes requires, without a toroidal field, favorable $\int dl/B$, and with a toroidal field a new generalization of the V$''$ criterion. Even with these criteria satisfied residual flute instabilities occur depending on resonant particle effects. Two modes are found: an electron flute with $\omega/\omega_{*e} > 0$ destabilized if $\omega_{bi} < \omega < \omega_{be}$ by electron resonances provided $T_i/T_e < L^2/r\bar{R}$, and an ion flute with $\omega/\omega_{*i} > 0$ destabilized if $\omega \gtrsim \omega_{bi}$ by ion resonances requiring finite Debye length and $k_\perp^2\lambda_{Di}^2 > (1 + T_e/T_i)\, r/\bar{R}$, though having an exponentially small growth rate if $(1 + T_e/T_i)\, 4\pi\rho c^2/B^2 > r\bar{R}/L^2$. Here $\omega_{*i,e}$ are the diamagnetic drift frequencies, r the density scale length, $\bar{R}$ the average radius of curvature, and L the connection length. The small shear order $(m/M)^{1/4}$ required for flute mode stability is calculated; for systems unstable to the generalized V$''$ criterion, the residual ion instability is insensitive to shear. Slight anisotropy or temperature gradient also affects the stability of the residual ion flute, but quasi-linear calculations indicate that the nonlinear formation of a sufficient stabilizing anisotropy is slow. The drift ballooning mode local to a bad curvature region and the drift universal mode are unstable for $\omega_{bi} < \omega < \omega_{be}$ provided $T_i/T_e < L^2/r\bar{R}$ and $T_i/T_e < L/r$ respectively. An eikonal procedure provides the effect of shear on the ballooning mode including geodesic curvature; stability is found with finite shear and large $T_i/T_e$. Trapped particle modes have $\omega < \omega_{bi}$. Curvature driven modes, insensitive to shear but stable in maximum-J configurations, are also stabilized if r/R is not too small, and criteria are given but can be very restrictive. For large $k_\perp$ a new overstable mode relatively insensitive to shear, independent of curvature, and not involving resonant particles is found requiring terms of order $(\omega/\omega_{bi})^{1/2}$ and $k_\perp^2 a_i^2$, where $a_i$ is the ion Larmor radius: instability occurs if $k_\perp^2 a_i^2 > (1 + T_i/T_e)\, r/L$. (auth)

**46191** (SU-IPR-249) RESEARCH ON ANOMALOUS DIFFUSION AND INSTABILITIES IN INHOMOGENEOUS PLASMAS. Annual Progress Report. Thomassen, K. I.; Derfler, H. (Stanford Univ., Calif. Inst. for Plasma Research). Aug. 1968. Contract AT(04-3)-326. 48p. Dep. CFSTI.

Instabilities and transport in a cold cathode reflex discharge were studied. Progress on the stabilization of drift waves by externally applied random fields is described. The work on surface-wave instabilities in a bounded uniform-density plasma cylinder which was begun during this contract period is briefly described also. Finally, the design work on a Q machine to be built from an existing thermionic diode is described. (auth)

**46192** (TID-24649) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 9, December 1, 1967–February 29, 1968. Lashinsky, H. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3405. 9p. Dep.

Experimental measurements of mode spectra were made in the Univ. of Maryland Q device. The results are briefly described. (M.O.W.)

**46193** (TID-24666, pp 135-44) EXPERIMENTAL STUDY OF ENHANCED CYCLOTRON RADIATION FROM AN EL CTRON-CYCLOTRON RESONANCE DISCHARGE. Speck, C. E.; Bers, A. (Massachusetts Inst. of Tech., Cambridge).

The study of the intense instability occurring in the afterglow of a pulsed electron-cyclotron resonance discharge is continued. The radiation measurements presented previously are enlarged. The density evolution of the plasma is interpreted in terms of a simple model. Comparisons are made between a number of the basic characteristics of the discharge. (M.O.W.)

**46194** PLASMA TURBULENCE. Samaras, Demetrios G. Res. Rev. (Office Aerosp. Res.), 7: No. 4, 18-19(Apr. 1968).

Some definitions and characteristics of plasma turbulence are discussed: energy loss (heating), independent electric conductivity, hierarchy of eddies. The variation of diffusion current with magnetic field in the laminar and turbulent regions is described. The theory of plasma turbulence as developed by Drummond et al. and the work by Jen on electromagnetic turbulence are discussed. (D.L.C.)

# Shielding

*Refer also to abstracts 45925, 45926, 46301, 46568, and 46572.*

**46195** (ORNL-TM-2284) REVISED NEUTRON KERMA VALUES AT THE BOUNDARY OF A SEMI-INFINITE CONCRETE MEDIUM. Schmidt, F. A. R. (Oak Ridge National Lab., Tenn.). July 10, 1968. Contract W-7405-eng-25. 17p. Dep. CFSTI.

The values of the kerma at the boundary of a semi-infinite concrete medium for several incident neutron energies have been estimated from published albedo values. These values have been used to revise the data of Clark, Betz, and Brown which give kerma as a function of concrete thickness. (auth)

**46196** (ORNL-tr-1949) AN ANALYTIC SOLUTION OF THE MULTILAYER PROBLEM IN THE BUILDUP CALCULATION. Zumach, W. Translated for Oak Ridge National Lab., Tenn., from Atomkernenergie, 12: 20-4(1967). 14p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 21: 27231. (W.H.K.)

# Solid-State Physics

*Refer also to abstracts 45028, 45029, 45107, 45785, 46061, 46062, 46353, 46724, 46726, 46729, 46745–46747, 46750, 46753, 46775, 46790, 46792, 46798–46803, 46831, 46839–46841, and 46844–46846.*

**46197** (N-68-25392) ANNEALING OF HIGH-ENERGY PROTON DAMAGE IN SILICON. Beatty III, Marvin E.; Hill, Gerald F. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Mar. 30, 1967. 20p. (CONF-670334-1; NASA-TM-X-59638). CFSTI.

From 6th IEEE Photovoltaic Specialists Conference, Cocoa Beach, Fla.

The results of studies using n- and p-type silicon irradiated with 22-, 40-, and 158-MeV protons and annealed at 100, 200, and 300°C are reported. The results show that proton damage is very complex and difficult to anneal in comparison to electron damage. A flux dependence was found for protons, which is compared to one previously reported with electrons. There is also an energy-dependence result reported. A peculiar effect of increasing and decreasing minority carrier lifetime observed during isothermal annealing is discussed. (auth)(STAR)

**46198** (NP-17602) SURFACE AND VACUUM PHYSICS INDEX. Volume 3, No. 5(543-676). Hilsenbeck, D. (ed.). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 70p. Dep.

A listing of 133 articles on various aspects of surface and vacuum physics is presented. Subject and author indexes are included. (M.O.W.)

**46199** (UCRL-18043, pp 183-98) SOLID-STATE PHYSICS. (Univ. of California, Berkeley).

Research during 1967 in the following areas is summarized briefly: theoretical solid state physics, magnetic properties of solids, far-infrared properties of solids, superconductivity, experimental solid state physics and quantum electronics, and nuclear spin interactions. Limited data are included on low-lying energy levels for $Ti^{3+}$ and $V^{4+}$ ions in $Al_2O_3$ and for the $Fe^{3+}$ ion in several compounds from studies using far-infrared spectroscopy. A scheme for NMR-NQR detection in solids, results of its application to $^{13}C$ and deuterium in paradichlorobenzene, and results of observations of the nuclear electric quadrupole interaction of $^{14}N$ in phenothiazine at zero magnetic field are described briefly. Research plans for 1968 are outlined. (A.G.W.)

**46200** A REVERSIBLE NUCLEAR RADIATION APPROACH TO GENERATION-RECOMBINATION NOISE STUDIES IN Ge SINGLE CRYSTALS. McCarter, Ed Raymond. Stillwater, Okla., Oklahoma State Univ., 1967. 80p.

Thesis.

The development of a reversible technique for use in varying the important parameters of a semiconductor as applicable to the study of generation-recombination noise was investigated. In particular, a method was sought for varying in a reversible manner the bulk lifetime and apparent doping of a semiconductor over a wide range while leaving other parameters, such as physical dimensions, contacts, and surface properties, unchanged. With the use of 14.7-MeV monoenergetic neutrons and $^{60}Co$ gamma rays (1.17 MeV and 1.33 MeV), the lifetime of a germanium single crystal was changed by a factor of $10^3$, and the apparent doping changed from n to p. By annealing the crystals at temperatures up to 550°C, these crystal parameters were restored to within 20 percent of their original value. The crystal physical dimensions and surface properties remained unchanged within the limits of measurement. New-type noise spectra were found in gamma-irradiated crystals. With the use of the above-mentioned reversible technique, a more detailed study should be made of these new type spectra in order to provide an experimental background for an extended noise theory. In particular, detailed information can be gained about transition probabilities in a multilevel system. (Diss. Abstr.)

**46201** MAGNETIC PROPERTIES OF SOME 2:17 INTERMETALLIC COMPOUNDS OF LANTHANIDE METALS WITH NICKEL. Carfagna, Paul Darwin. Pittsburgh, Univ. of Pittsburgh, 1967. 92p.

Thesis.

The binary intermetallic compounds $Ln_2Ni_{17}$, where Ln = Y, Sm, Gd, Tb, Dy, Ho, Er, Tm, and Lu, have been investigated to determine their bulk magnetic properties. The compounds were prepared by levitation melting and annealed at appropriate temperatures. Room-temperature x-ray powder diffraction patterns showed that the $Ln_2Ni_{17}$ compounds had the hexagonal $Th_2Ni_{17}$ type structure. Lattice parameters were obtained. Saturation moments at 4.2°K and thermomagnetic analysis data from 4.2 to ~640°K were obtained. The saturation data at 4.2°K can be satisfactorily explained by a two-sublattice model in which the lanthanide ions make up one ferromagnetic sublattice and the nickel atoms make up a second ferromagnetic sublattice. These two sublattices are then coupled ferromagnetically or antiferromagnetically for the light and heavy lanthanide compounds respectively. By making certain logical assumptions regarding electron transfer from the lanthanide ion to the nickel d-band, an average moment of 0.25 $\mu_B$ per nickel atom was calculated for the $Ln_2Ni_{17}$ compounds. From the saturation moments of $Y_2Ni_{17}$, $Lu_2Ni_{17}$, and $Gd_2Ni_{17}$, the average moment carried per nickel atom was found to be 0.27 $\mu_B$. The thermomagnetic-analysis data showed that the Ni-Ni interaction was dominant since Curie points were observed in the temperature range 600° to 640°K for the compounds prepared. The assignment of antiferromagnetic coupling of the lanthanide and nickel moments was further verified in the case of the heavy lanthanide (Gd through Tm) compounds by the observation of a compensation point. The thermomagnetic behavior of the $Y_2N_{17}$ and $Lu_2Ni_{17}$ compounds showed that a simple two-sublattice model did not give an adequate representation of the data. These two compounds exhibited a double demagnetization, the first "Curie point" occurred at ~170°K and the second above 600°K. The possibility that the unusual thermomagnetic behavior of $Y_2N_{17}$ and $Lu_2Ni_{17}$ and the high Curie temperature found in the other $Ln_2Ni_{17}$ compounds was the result of free nickel impurity was excluded by various considerations. The results show that the magnetic properties of the $Ln_2Ni_{17}$ compounds are quite different than other Ln-Ni compounds reported. This difference is mainly attributed to the existence of a moment of the nickel atoms. (TSS) (Diss. Abstr.)

**46202** COMPARISON OF DEFECTS INJECTED INTO PLATINUM BY QUENCHING AND BY RADIATION DOPING. Jackson, J. J. (Argonne National Lab., Ill.); Herschbach, K. Phys. Rev., 173: 664-76(Sept. 15, 1968).

Specimens made from pure, well-annealed platinum, from quenched platinum, and from platinum that had been previously irradiated below 100°K and annealed to above room temperature were bombarded simultaneously below 7°K with 20-MeV deuterons. Damage production and recovery in the three types of specimens were compared in detail. Both of the preirradiation treatments increase the sink density for interstitials mobile in stage I. The initial defect production rate is increased by the presence of vacancy clusters and decreased by the presence of interstitial clusters. (auth)

**46203** OPTICAL WAVEGUIDES FORMED BY PROTON IRRADIATION OF FUSED SILICA. Schineller, E. Ronald; Flam, Richard P.; Wilmot, Donald W. (Wheeler Labs., Inc., Smithtown, N. Y.). J. Opt. Soc. Amer., 58: 1171-6(Sept. 1968).

Various techniques for fabricating optical waveguides for laser-oriented applications are being studied. A technique utilizing radiation-induced changes of refractive index in optical materials is presented; the particular waveguide considered is a fused-silica slab that has been irradiated with protons to produce a channel with a refractive index slightly higher than the unirradiated silica. This high-index channel serves as the waveguide core and the surrounding unirradiated region as the cladding. Formulas for determining the size and shape of the high-index channel and the amount of index change have been developed. The primary waveguide parameters, core size, and refractive-index difference may be adjusted by controlling proton energy and dosage, respectively. The technique is useful for formation of waveguides with core widths of 1 to 50 $\mu$ and index differences of 0.01 to 0.0001; it is particularly suitable for forming complex arrays of waveguides and waveguide components. Preliminary experimental work has used 1.5-MeV protons and dosages of $10^{14}$ to $10^{17}$ protons/cm$^2$. Light propagation has been observed in waveguides formed by this technique. (auth)

**46204** RECOMBINATION LIFETIMES IN GAMMA-IRRADIATED SILICON. Hewes, Ralph A. (Univ. of Illinois, Urbana). J. Appl. Phys., 39: 4106-23(Aug. 1968).

Photoconductivity decay measurements on a wide variety of silicon crystals (boron- and phosphorus-doped, Czochralski and float-zone grown, $20 \leq \rho \leq 200\ \Omega\cdot$cm) irradiated with $^{60}Co$ gamma rays indicate that a separate system of levels controls the radiation-induced lifetime in n- and p-type specimens. In n-type material the introduction rates for two recombination active defects (the A center and a deeper level) were seen to be nearly independent of oxygen and donor concentrations in the range encountered in the experiment, while the introduction rate of a second deep level, the E center (vacancy-phosphorus pair), was seen to be inhibited by the presence of oxygen and to increase with increasing donor concentrations. The behavior of the lifetime was studied after the samples were annealed and it was found that a shallow level 0.23 eV from the conduction band edge was introduced. Hole-capture cross sections for the two deep levels were obtained from Hall and lifetime measurements. In p-type material recombination levels at $E_v + 0.18$ eV and $E_c - 0.3$ eV were introduced by irradiation. The introduction rate of the level nearest the conduction band was strongly inhibited by the presence of oxygen and dominated the lifetime only in float-zone material. Low-temperature annealing was seen to occur in the defects having levels at $E_c - 0.3$ eV with the subsequent creation of defects with levels at $E_v + 0.18$ eV in some materials. In other materials a second type of defects with levels at $E_c - 0.3$ eV was created, while in some materials a simple annealing with no creation of new defects was found. (auth)

**46205** HARDENING OF IONIC CRYSTALS BY NEUTRON AND GAMMA IRRADIATION: STUDY OF THE NaCl AND KCl SINGLE CRYSTALS. Maeng, Sun-chae; Choi, Hyung-sup; Kim, In-sup (Korea Inst. of Science and Technology, Seoul). J. Appl. Phys., 39: 4404-7(Aug. 1968).

The effect of neutron or gamma irradiation on the critical shear stress of sodium chloride and potassium chloride crystals was studied. Until the irradiation dosage reached $10^{16}$ nvt, the rate of increase in the critical shear stresses was very small. However, critical shear stress of these crystals increased mark-

edly when the dosage of the neutron irradiation exceeded $10^{16}$ nvt. At the total neutron dosage of $5 \times 10^{17}$ nvt, the critical shear stress of sodium chloride and potassium chloride increased about 13 times and three times, respectively. Gamma irradiation caused significant hardening of NaCl when the dosage exceeded $10^7$ R. When the irradiation dosage reached $3 \times 10^8$ R, the critical shear stress of NaCl increased about 11 times. The pre-irradiated sodium chloride crystals were annealed in the temperature range of 200 to 300°C, and the activation energy for the recovery of radiation hardening was found to be 0.35 to 0.48 eV. (auth)

**46206** USE OF ANOMALOUS X-RAY TRANSMISSION FOR THE DETECTION OF DEFECTS PRODUCED IN SILICON AND GERMANIUM BY FAST NEUTRON IRRADIATION. Baldwin, T. O.; Thomas, J. E. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 39: 4391-8(Aug. 1968). (ORNL-P-3702).

Absolute x-ray intensities anomalously transmitted through fast-neutron-irradiated silicon and germanium crystals were measured and compared with those transmitted through nearly perfect (unirradiated) crystals. The results indicate that the Borrmann intensities in both silicon and germanium irradiated with $4 \times 10^{19}$ fast neutrons/cm$^2$ (E > 0.6 MeV) were reduced by nearly a factor of two for $\mu_0 t_0 \approx 30$. In contrast, very small (<5%) decreases in the Bragg intensities diffracted from the surfaces were observed. The observed decreases in intensity have been attributed to the strains in the vicinity of "disordered regions," previously observed in electron-microscopy studies of irradiated germanium. Isochronal annealing studies have demonstrated that the crystals could be restored to near their original state of perfection by heating to ≈700°C for 30 min. Two well-defined annealing peaks were found in both kinds of crystals, silicon annealing at about 190° and 630°C, and germanium at about 150° and 400°C. These studies suggest that fast-neutron doses at ambient temperature in the range of $10^{19} - 10^{20}$/cm$^2$ (E > 0.6 MeV) are necessary for observations of appreciable effects on the x-ray intensities diffracted from silicon and germanium. (auth)

**46207** ISOTOPE EFFECTS IN THE LATTICE CONSTANT AND THERMAL EXPANSION OF $^{20}$Ne AND $^{22}$Ne SINGLE CRYSTALS. Batchelder, D. N.; Losee, D. L.; Simmons, R. O. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Rev., 173: 873-80(Sept. 15, 1968).

Single crystals of $^{20}$Ne and $^{22}$Ne were grown by directional solidification from the liquid, and the x-ray lattice constants were measured by means of a rotating-camera method. The volume coefficients of thermal expansion were determined over the interval 2.5 to 24.3°K with a precision ranging from 5 ppM °K$^{-1}$ at low temperatures to 18 ppM °K$^{-1}$ at the highest temperature. The lattice constants extrapolated to 0°K are 4.46440 Å* for $^{20}$Ne and 4.45589 Å* for $^{22}$Ne, within an estimated maximum error 0.00008 Å*. Several current lattice-dynamical models adequately describe the isotopic difference in the lattice constant at 0°K, while at finite temperatures the description is unsatisfactory. (auth)

**46208** RAMAN SPECTRUM OF $LaBr_3$. Asawa, C. K. (Hughes Research Labs., Malibu, Calif.). Phys. Rev., 173: 869-72(Sept. 15, 1968).

The first-order Raman spectrum of $LaBr_3$ is examined. All of the six Raman-active vibrations are observed and the $C_{6h}$ point-group symmetry assignments for the lines are given: 83 cm$^{-1}$, $E_{2g}$; 116 cm$^{-1}$, $A_g$; 122 cm$^{-1}$, $E_{1g}$; 137.6 cm$^{-1}$, $A_g$; 139.2 cm$^{-1}$, $E_{2g}$; 146 cm$^{-1}$, $E_{2g}$. The lines at 137.6 cm$^{-1}$ and 139.2 cm$^{-1}$ are found to be resolvable at 77°K but not at temperatures above 180°K. The Raman spectrum of $LaBr_3$ is compared with that of the isomorphic $LaCl_3$, which exhibits only five of the six Raman-active lines. (auth)

**46209** ENERGY BANDS AND FERMI SURFACE OF SCANDIUM. Fleming, G. S.; Loucks, T. L. (Ames Lab., Iowa). Phys. Rev., 173: 685-8(Sept. 15, 1968). (IS-1786).

The energy bands for hexagonal close-packed scandium have been calculated using the augmented-plane-wave method. From these calculations, the Fermi surface, density of states at the Fermi energy, and electronic specific-heat coefficient were determined. An important feature of the Fermi surface is the existence of large relatively parallel portions perpendicular to the c axis. This feature has also been reported for Y, Lu, Er, and Dy and in the present case can be related to the wave vector of the periodic moment arrangement occurring in alloys of Sc and Tb. Comparisons with the limited number of experimental data are made. There is no indication that the electronic specific-heat coefficient enhancement (due to electron–phonon and electron–electron interactions) is significantly greater for Sc than for Y and the heavy rare earths. (auth)

**46210** HIGH-FIELD GALVANOMAGNETIC PROPERTIES OF NIOBIUM. Reed, W. A.; Soden, R. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 173: 677-9(Sept. 15, 1968).

The results of high-field galvanomagnetic measurements on a single crystal of niobium with a residual resistance ratio of 4750 are reported. These results resolve most of the uncertainties regarding the Fermi-surface topology of niobium, which existed in previously reported data because of limited sample purity. (auth)

**46211** ABSOLUTE THERMOELECTRIC POWER OF Cr–Mo ALLOYS BETWEEN 100 AND 600°K. Schroeder, Klaus; Tomaschke, Harry (Syracuse Univ., N. Y.). Phys. Kondens. Mater., 7: 318-24(July 11, 1968).

Thermoelectric power measurements on Cr–Mo alloys showed that the Seebeck coefficient S of alloys with more than 25 at. % Mo was a linear function of temperature between 100 and 500°K. S showed a more complex temperature dependence for antiferromagnetic samples, with S(T) having a peak below the Néel temperature. The onset of antiferromagnetism was close to the minimum in the S(T) curve. The energy change associated with antiferromagnetic ordering is of the same order of magnitude as the energy gap predicted by the spin density wave theory. (auth)

**46212** LATTICE-DYNAMICAL PROPERTIES OF $^{57}$Fe IMPURITY ATOMS IN Pt, Pd, AND Cu FROM PRECISION MEASUREMENTS OF MOESSBAUER FRACTIONS. Nussbaum, Rudi H.; Howard, Donald G.; Nees, Wilbur L.; Steen, Charles F. (Portland State Coll., Oreg.). Phys. Rev., 173: 653-63(Sept. 15, 1968).

Precision measurements of the Moessbauer fractions of $^{57}$Fe in single crystals of Cu, Pd, and Pt were obtained over a range from liquid-helium temperatures to around 750°K in about 50°K intervals, using the "black wide absorber" technique. The overall accuracy is estimated to be better than 0.7%, with a somewhat larger error for Pt. The data are consistent with a harmonic lattice with small cubic and quartic anharmonic contributions. Properly weighted Debye temperatures $\Theta_D(-1)$ and $\Theta_D(-2)$ were derived from the low- and high-temperature limits of the f measurements, which were compared with equivalent data for the pure hosts. It is concluded that Fe in Cu is about 20% more strongly bound than Cu in Cu, while Fe in Pd and Pt shows about a 20% weaker average force constant than the host atoms. Fe in Cu also has a much larger degree of anharmonicity than pure Cu. Analysis of earlier data on Fe in Ni shows a similar behavior. The data were also examined for evidence of localized impurity modes. The low-temperature data for Fe in Pt are consistent with the existence of a predicted localized mode, but they do not provide unambiguous evidence. (auth)

**46213** ELECTRON SPIN RESONANCE STUDIES OF GAMMA-IRRADIATED GLASSES CONTAINING LEAD. Kim, Y. M.; Bray, P. J. (Brown Univ., Providence). Contract AT(30-1)-2024. J. Chem. Phys., 49: 1298-1301(Aug. 1, 1968).

Electron spin resonance (ESR) studies have been made of lead borate and lead silicate glasses gamma irradiated and maintained at liquid-nitrogen temperature. In lead borate glasses of low PbO content, a spectrum similar to the five-line spectrum which has been observed in alkali borate glasses was observed, while a different, asymmetric spectrum appeared in glasses of high lead oxide content. This latter spectrum is identified as due to the $O^-$ center near one or more $Pb^{++}$ ions. (auth)

**46214** CHANNELLING OF PARTICLES IN CRYSTALS. Thompson, M. W. (Univ. of Sussex, Brighton, Eng.). Contemp. Phys., 9: 375-98(July 1968).

Open channels exist between the rows or planes of atoms in a crystal. In experiments with carefully defined beams of energetic ions it is possible to inject particles into these channels, in which they travel with relative ease, being reflected back and forth between the channel walls by a correlated series of atomic collisions. The main types of experiments on this phenomenon are summarized and the classical theory is developed. Classical treatment is not adequate for light particles, such as electrons or positrons, because their de Broglie wavelength is greater and a wave mechanical version is outlined in a form which is also suitable for describing protons. This confirms that for heavy particles classical theory can explain any experiments performed so far, but it is possible that the interpretation of more precise proton experiments may require wave mechanisms. (auth) (UK)

**46215** INVESTIGATION OF MAGNETIC STRUCTURE AND DYNAMICS IN SOLIDS WITH NEUTRON BEAMS. Low, G. G. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 219: 895-9(Aug. 31, 1968).

Techniques involving neutron scattering allow the internal struc-

ture and dynamics of magnetic materials to be examined with a degree of experimental definition unobtainable by other methods. Some results are given for ferromagnetic iron, MnO, heavy rare earth metals, antiferromagnetic $MnF_2$, etc. (auth) (UK)

**46216** SAPPHIRE LUMINESCENCE UNDER X-RAY EXCITATION. Runciman, W. A. (Atomic Energy Research Establishment, Harwell, Eng.). Solid State Commun., 6: 537-9(Aug. 1968).

A comparison is made of the luminescence bands at 165 nm and 250 nm emitted under x-irradiation by two nominally pure crystals of sapphire, $Al_2O_3$, at 4°K and 77°K. The band at 165 nm is believed to be intrinsic and to be the first example of solid state luminescence in the vacuum uv. (auth) (UK)

**46217** CENTRAL FORCE LATTICE DYNAMICAL MODEL FOR ZIRCONIUM HYDRIDE. Slaggie, E. L. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. J. Phys. Chem. Solids, 29: 923-34(June 1968). (GA-8132).

A central force lattice dynamical model for $ZrH_2$ has been constructed, following the methods of Born and von Kármán. Four force constants are introduced, representing the central force interactions out to second nearest neighbors for zirconium atoms and third nearest neighbors for hydrogen atoms. The relationship between the shape of the frequency distribution and the interatomic forces is studied numerically by means of root-sampling calculations of the frequency distribution for various force constant values. It is found that reasonable values of the force constants lead to frequency distributions which are for the most part consistent with specific heat and neutron double differential scattering data. Some detailed comparisons between calculated and experimental results for the specific heat and for neutron double differential scattering are presented. (auth) (UK)

**46218** NUCLEAR ORIENTATION OF $^{54}$Mn NUCLEI IN NOBLE METAL HOSTS. Compton, J. P.; Williams, I. R.; Wilson, G. V. H. (Oxford Univ.). pp 793-8 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Measurements are reported of the anisotropy of the 0.84-MeV $\gamma$ radiation from $^{54}$Mn nuclei polarized in copper, silver, and gold hosts at temperatures from 0.01 to 0.04°K in applied fields up to 15 kOe. The temperature and applied-field dependences of the deduced values of the hyperfine fields at the $^{54}$Mn nuclei are very different from the Brillouin function expected for ideal paramagnetic behavior. For manganese in gold, the results can be well explained by assuming that a random interaction field of order 8 kOe acts at the manganese ions, but such a model is incompatible with the results for copper and silver hosts. A more likely explanation is the formation at low temperatures of spin-compensated bound states which may be destroyed by sufficiently large applied magnetic fields. (auth)

**46219** $T_1$ MEASUREMENTS FOR IMPURITIES IN FERROMAGNETIC ALLOYS BY NUCLEAR ORIENTATION. Reid, P. G. E.; Sott, M.; Stone, N. J. (Oxford Univ.). pp 799-802 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

By observation of the growth of $\gamma$-ray anisotropy upon magnetic polarization of dilute alloys of $^{198}$Au, $^{60}$Co, $^{192}$Ir, and $^{122}$Sb in iron, cooled to temperatures in the range 0.1 to 0.01°K, the nuclear spin-lattice relaxation times of these nuclei were measured. (auth)

**46220** MEASUREMENT OF NUCLEAR SPIN-LATTICE RELAXATION TIMES BY NUCLEAR ORIENTATION METHODS. Turrell, B. G. (Univ. of British Columbia, Vancouver). pp 803-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Measurement by nuclear orientation methods of the nuclear spin-lattice relaxation time, $T_1$, in ferromagnetic alloys is discussed. Preliminary measurements yield values of $T_1$ for the $^{60}$Co-Fe alloy and the $^{198}$Au-Fe alloy satisfying $(T_1T)_{Co-60} = 1.0 \pm 0.3$ sec °K and $(T_1T)_{Au-198} = 0.9 \pm 0.3$ sec °K over the temperature range 0.014 to 0.022°K. (auth)

**46221** HYPERFINE INTERACTION OF CHROMIC IONS CONTAINING RADIOACTIVE $^{51}$Cr NUCLEI ORIENTED IN A SINGLE CRYSTAL OF Ce-Mg NITRATE. Sapp, R. C.; Taylor, H. F. Jr. (Univ. of Kansas, Lawrence). pp 807-12 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The substantial anisotropy of 325-keV $\gamma$ radiation following decay of $^{51}$Cr oriented by the method of magnetic hfs alignment in Ce - Mg nitrate crystal sites was measured. The samples were slightly cloudy spherical and naturally shaped single crystals cooled by adiabatic demagnetization from initial conditions up to 21.6 kOe/°K to zero final magnetic field. At the lowest temperature, angular distributions $W(\theta) = 1 + A_2P_2(\cos\theta)$ where $A_2 = +0.260 \pm 0.016$ and $0.239 \pm 0.016$, respectively (corrected for finite counter geometry). The temperature dependence of $A_2$ for the sphere is consistent with that of the nuclear alignment parameter $B_2(A/kT)$; and by fitting this temperature dependence, $A/k = 2.5(3) \times 10^{-3}$ °K is obtained, if the Ce - Mg nitrate temperature scale of Hudson and Kaeser is used, where A is the coefficient in the Cr hfs Hamiltonian $A\vec{I} \cdot \vec{S}$ with $S = 3/2$, $I = 1/2$. The magnetic moment of $^{51}$Cr is 1.1(1) nm. These results indicate that $29 \pm 2\%$ of the $^{51}$Cr was at crystal sites in the sphere, assuming there was no intermediate-state reorientation. (auth)

**46222** RESONANT DESTRUCTION OF NUCLEAR ORIENTATION IN A DILUTE PARAMAGNETIC CRYSTAL. Niesen, L.; Lubbers, J.; Huiskamp, W. J. (Kamerlingh Onnes Lab., Leiden). pp 894-901 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Transitions between the hyperfine-structure levels of $^{54}$Mn, oriented in $La_2Mg_3(NO_3)_{12} \cdot 24H_2O + 0.1\%$ Ce, were induced by radiofrequency radiation. Narrow resonance lines were observed, and different hfs transitions could be induced separately. (auth)

**46223** HYPERFINE STRUCTURE IN A FLUCTUATING ENVIRONMENT. Blume, M. (Brookhaven National Lab., Upton, N. Y.). pp 911-27 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The theory of hyperfine structure in the presence of time-dependent electronic fluctuations (such as those induced by electron spin relaxation) is considered. A general expression applicable to the Moessbauer line shape, perturbed angular correlations, angular correlation NMR, and resonance in oriented nuclei is derived. A number of realistic, exactly soluble stochastic models for relaxation phenomena are presented and compared with perturbation-theoretic treatments such as those of Abragam and Pound and Bradford and Marshall. The theory is applied to the calculation of the Moessbauer line shape, and also to the calculation of angular correlations of successive nuclear decays. (auth)

**46224** TEMPERATURE DEPENDENCE OF THE ELECTRONIC RELAXATION IN DYSPROSIUM ETHYLSULFATE AND DYSPROSIUM GALLIUM GARNET. Huefner, S.; Wickman, H. H.; Wagner, C. F. (Bell Telephone Labs., Murray Hill, N. J.). pp 952-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect of the 26.5-keV transition of $^{161}$Dy was employed to study relaxation effects in dysprosium ethylsulfate (DyES) and dysprosium gallium garnet (DyGaG). The relaxation times determined from the Mössbauer spectra were found to be faster than the corresponding rates extrapolated from the results obtained with "standard" relaxation time measurements. In DyGaG a single line is observed at 4.2°K. This garnet should therefore be useful as a single-line low-temperature source. (auth)

**46225** SUPERPARAMAGNETISM OF FERRITE PARTICLES. McNab, T. K.; Boyle, A. J. F. (Univ. of Western Australia, Nedlands). pp 957-64 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The hyperfine spectra for cobalt and manganese ferrites were recorded for a range of particle size and temperature. Calculations using a simple model of the relaxation give values of the anisotropy energy and the width of the particle size distribution. The latter is compared with the results from other methods. Spectra have also been obtained and analyzed for one ferrite sample with a very narrow size distribution. (auth)

**46226** MAGNETIC ORDERING TEMPERATURES OF THE SINGLE CRYSTALS OF RARE EARTH METALS AT HIGH PRESSURES: GADOLINIUM, TERBIUM, AND DYSPROSIUM. Bartho-

lin, H.; Bloch, D. (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). J. Phys. Chem. Solids, 29: 1063-75(June 1968).

The magnetic ordering temperatures of single crystals of gadolinium, terbium and dysprosium were determined experimentally at hydrostatic pressures up to 6kbar. The Curie temperature of gadolinium decreases with pressure at the rate of $(-1.40 \pm 0.02) \times 10^{-3}$ °K bar$^{-1}$. At high temperatures terbium and dysprosium undergo an antiferromagnetic–paramagnetic transition at the Néel temperature $\theta_N$, and at lower temperatures a ferromagnetic–antiferromagnetic transition at the Curie temperature $\theta_C$. For terbium $d\theta_N/dp = (-0.84 \pm 0.02) \times 10^{-3}$ °K bar$^{-1}$ and $d\theta_C/dp = (-1.24 \pm 0.02) \times 10^{-3}$ °K bar$^{-1}$; for dysprosium $d\theta_N/dp = (-0.41 \pm 0.01) \times 10^{-3}$ °K bar$^{-1}$ and $d\theta_C/dp = (-1.27 \pm 0.02) \times 10^{-3}$ °K bar$^{-1}$. These variations result from the modifications of the exchange and anisotropy energies with the interatomic distances. At atmospheric pressure they contribute to the variations of the crystallographic parameters and the magnetic structures with temperature, but are insufficient for a complete interpretation. (auth) (UK)

**46227** HIGH-DEGREE EXCHANGE INTERACTION BETWEEN RARE-EARTH IONS. Baker, J. M.; Birgeneau, R. J.; Hutchings, M. T.; Riley, J. D. (Clarendon Lab., Oxford). Phys. Rev. Lett., 21: 620-3(Aug. 26, 1968).

From the EPR spectra of pairs of $Ce^{3+}$ and $Nd^{3+}$ ions in $LaCl_3$ and $LaBr_3$ it is possible to isolate contributions to the interaction tensors from high-degree anisotropic superexchange interaction of the form $J_1^4(1)J_2^2(2)$ and $J_1^1(1)J_2^3(2)$. (auth)

**46228** $Cl^-$ $L_{23}$ ABSORPTION SPECTRA OF ALKALI CHLORIDES OBTAINED AT 80°K WITH SYNCHROTRON RADIATION. Iguchi, Yasuo (Kyoiku Univ., Tokyo); Sagawa, Takasi; Sato, Shigeru; (and others). Solid State Commun., 6: 575-8(Aug. 1968).

$Cl^-$ $L_{23}$ absorption spectra of alkali chlorides were obtained at 80°K with a 2-m grazing incidence spectrograph. Synchrotron radiation emitted from a 1.3-GeV electron synchrotron was used as a continuum background. The experimental results are interpreted in terms of x-ray exciton, electronic band structure, and two-electron excitation. (auth) (UK)

**46229** EFFECT OF PRESSURE ON f NUMBER AND ISOMER SHIFT FOR $^{57}$Fe IN Cu, V, AND Ti. Moyzis, J. A. Jr.; DePasquali, G.; Drickamer, H. G. (Univ. of Illinois, Urbana). Phys. Rev., 172: 665-70(Aug. 15, 1968).

The effect of pressure to 100 kbar on the Mössbauer resonance has been measured for $^{57}$Co($^{57}$Fe) in Cu, V, and Ti. Bridgman anvils were used to establish the f number as a function of pressure. For Cu the characteristic temperature $\theta$ calculated in this way compares closely with that obtained from x-ray Bragg line intensities or room-temperature specific heats. For Ti the comparison with room-temperature specific-heat data is good. For V the $\theta$ obtained compares closely with low-temperature specific-heat values for impure samples, but is low compared with values obtained on very pure samples. The isomer-shift changes with pressure are analyzed briefly in terms of 4s–3d electron transfer. (auth)

**46230** DIRECT DETERMINATION OF THE STRUCTURE FORMED BY CRYSTAL MAGNETIC FIELDS AT NUCLEI HAVING MOESSBAUER ISOTOPES. Belyaev, V. A.; Aivazyan, Yu. M. (All-Union Research Inst. of Physico-Technical and Radio Measurements, Moscow). JETP Lett. (USSR) (Engl. Transl.), 17: 368-70(June 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 477-80(June 20, 1968).

It is shown that the character of the interference in Moessbauer scattering of $\gamma$ quanta by a crystal depends on the structure formed by the crystal magnetic fields at the nuclei of the Moessbauer isotope and also depends on the magnetic structure of the crystal. An analysis of the picture of the diffraction and polarization of the Moessbauer radiation at the Bragg maxima makes it possible to determine the structure formed by the magnetic fields at the crystal lattice sites containing the Moessbauer nuclei. The physical cause of the influence of the magnetic structure on the character of the Moessbauer scattering lies in the dependence of the amplitude of the Moessbauer scattering on the direction of the magnetic field at the scattering nucleus. (A.G.W.)

**46231** ANOMALOUS TEMPERATURE DEPENDENCE OF SPIN DENSITY IN $PrF_3$ SINGLE CRYSTALS. Afanas'ev, M. L.; Gabuda, S. P.; Lundin, A. G. (Inst. of Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.), 17: 352-4(June 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 451-4(June 20, 1968).

During an investigation of paramagnetic single crystals, it was observed that in the case of $PrF_3$ the position of one of the components of the NMR spectrum of $^{19}$F relative to the remaining lines of the spectrum varied continuously with temperature. This effect was observed only when the magnetic field was applied to the crystals at a certain angle to the threefold axis, the maximum deviation taking place when $H_0$ was perpendicular to the axis. The maxima of four components of the spectrum shift linearly with changing temperature. The unusual variation of the shift of the fifth component is attributed to the part played by the excited states of the unpaired 4f electrons in the formation of partially covalent bonds between the $^{141}$Pr and the $^{19}$F atoms. (A.G.W.)

**46232** ANGULAR CORRELATION AND MOESSBAUER NMR. Matthias, E. (Univ. of California, Berkeley). pp 816-42 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The general question of how to perform and detect nuclear magnetic resonance in radioactive isotopes is discussed. Gamma-ray detection of resonances in isomeric states is emphasized. The use of multipole radiation fields for detection introduces new and hitherto unobserved line shapes. For rf with random phase, the resonance line is k-fold split, where k is the summation index of the Legendre polynomial expansion. If pulsed rf with a constant phase is used, form and symmetry of the resonances depend strongly upon the phase and the geometry of the experiment. The existence of a "hard core" value at resonance frequency is demonstrated. Various geometries are examined with respect to their applicability in angular correlation or nuclear reaction experiments. The possibility of obtaining the relative sign of gH with respect to a reference case at certain geometries and by using linearly polarized rf with a fixed phase is discussed. Gamma-ray detection of NMR is not restricted to angular correlations and distributions but can also be performed by employing the Moessbauer effect. The principle is discussed, and preliminary results obtained with $^{57}$Fe are presented. Although the NMR interpretation is likely, the data do not, at present, unambiguously rule out the possibility of a frequency-modulation effect. (auth)

**46233** MAGNETIC RESONANCE IN ORIENTED NUCLEI. Shirley, D. A. (Univ. of California, Berkeley). pp 843-58 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The physical principles of magnetic resonance of oriented nuclei are discussed. The advantages of radiation detection are emphasized. Radiative detection offers much higher sensitivity than conventional means of resonance detection. More fundamentally, however, it offers the possibility of studying statistical (orientation) tensors of higher than first rank. As in angular correlation NMR, a response function of tensor rank k will exhibit in saturation an intrinsic fine structure consisting of k maxima. Only for odd k is complete destruction of anisotropy at resonance possible, if $T_2$ is long. The possibility of measuring several statistical tensors provides a stringent criterion for the existence of a spin temperature, $T_S$, in a realm of $T_S$ heretofore unavailable. The working equations that are used in discussing spin temperatures in conventional NMR are generalized for radiative detection experiments. Particularly the exponential decay to equilibrium $\exp(-t/T_1)$ must be modified for very low spin temperatures. Ultralow negative spin temperatures may be observed with radiative detection. Results obtained to date in ferromagnets are summarized. Spin-lattice relaxation times are discussed in terms of the orbital contribution, the s-band contribution, and additional relaxation from localized moments. It is shown that ferromagnets provide no special advantage because inhomogeneous broadening more than compensates for the ferromagnetic enhancement factor. Thus the NMR-ON technique is applicable to any substance in which a hyperfine field exists, and is feasible even when an external field alone is used. Preliminary experiments designed to achieve narrow lines, using single crystals of ferromagnetic metals, are described. (auth)

**46234** RESONANCE DESTRUCTION OF ANGULAR CORRELATIONS: $^{100}$Rh IN Fe AND Ni. Matthias, E.; Shirley, D. A.; Edelstein, N.; Koerner, H. J.; Olsen, B. A. (Univ. of California, Berkeley). pp 878-93 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

NMR absorption in the 235-nsec state of $^{100}$Rh was detected by angular correlations and with the use of the hyperfine fields of Rh

in Fe and Ni. Dependence of the resonance effect on rf power and polarization of the host foil has been studied. The observed line width as well as the power dependence can be qualitatively understood by comparison with theoretical expectations. Evidence for localized moments is found from the temperature variation of the resonance frequency. A possible $^{103m}Rh$-$^{103}Rh$ hyperfine anomaly is discussed. (auth)

**46235** MOESSBAUER EFFECT AND THE DYNAMICS OF THE MOLECULAR SOLID $SnI_4$. Hazony, Y. (Princeton Univ., N. J.). Contract AT(30-1)-2807. J. Chem. Phys., 49: 159-61 (July 1, 1968). (NYO-2807-50).

The available Mössbauer data on $^{119}Sn$ and $^{129}I$ in solid $SnI_4$ are analyzed in terms of a detailed molecular-dynamical model to give characteristic Einstein temperatures for the intermolecular translational and rotational vibrations: $\theta_1 = 44°K$ and $\theta_{rot} = 66°K$. $\theta_1$ is very close to the observed (ir) antitranslational vibrational frequency (48°K) of the eight molecules in the unit cell. The calculated specific heat, based on the present analysis, is consistent with the experimental results for $C_p$. (auth)

**46236** DETERMINATION OF PURITY BY NUCLEAR MAGNETIC RESONANCE. Herington, E. F. G.; Lawrenson, I. J. (National Physical Lab., Teddington, Eng.). Nature (London), 219: 928(Aug. 31, 1968).

A method of measuring melting points using NMR spectroscopy was described by Burnett and Muller (Nature, 219: 59(1968)). The present authors have used an NMR technique to determine the purity of organic compounds. A high resolution spectrometer operating at 40 MHz records the proton spectrum of the material under investigation from about 20° below melting point up to the temperature at which the sample is completely molten. The intensity of the measured liquid line gives the fraction melted, and a curve is plotted of temperature against reciprocal of fraction melted. This curve is linear for systems not forming solid solutions, the slope giving the purity of the sample and the intercept on the temperature axis giving the melting point of the pure material. Applications to phenol–water, phenol–cresol, and methylnaphthalene systems are described. Values of the distribution coefficient of impurity in the solid and liquid phases can be derived from the NMR data. For purity control the technique is stated to be quicker than other cryoscopic methods. (UK)

**46237** EXPERIMENTAL STUDIES OF SPIN RELAXATION PHENOMENA. Wickman, H. H. (Bell Telephone Labs., Murray Hill, N. J.). pp 928-47 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect has become an increasingly common technique for the study of time-dependent hyperfine interactions in iron systems and in several rare earth nuclei. The relative advantages and disadvantages of the Moessbauer technique over magnetic resonance and other methods employed for the determination of electronic and nuclear relaxation are briefly considered. A range of representative Moessbauer studies of relaxation is provided by investigations of trivalent iron complexes of the high- ($S = 5/2$), intermediate- ($S = 3/2$), or low-spin ($S = 1/2$) type. In most of these cases, information concerning electronic spin-spin interactions may be derived from the data. In the rare earth region, spin-lattice relaxation of the Orbach type is well known and is illustrated by the temperature dependence of relaxation effects in dysprosium ethyl sulfate. Recently, Nowik and Ofer, and Wiedemann and Zinn have investigated relaxation in several ordered rare earth systems; these results are summarized. (auth)

**46238** EXPERIMENTAL DETERMINATION OF THE COEFFICIENT OF RADIATION-STIMULATED DIFFUSION IN CdS. Kaneev, M. A. (Inst. of Nuclear Physics, Tashkent). Sov. Phys.-Solid State (Engl. Transl.), 10: 726-7(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 922-3(Mar. 1968).

CdS crystals were irradiated by $\alpha$ particles in a $\gamma$-ray field. The accumulation of Cd on the side opposite the side irradiated by the $\alpha$ particles, was determined as a function of $\gamma$-ray dose. A value of $D \sim 10^{-12}$ to $10^{-11}$ cm$^2$/sec was calculated for the coefficient of radiation-stimulated diffusion. (D.L.C.)

**46239** EFFECTS OF LIGHT, PROTONS, AND ELECTRONS ON THE OPTICAL PROPERTIES OF LITHIUM HYDRIDE. Gavrilov, F. F.; Dvinyaninov, B. L.; Stadukhin, V. M.; Shul'gin, B. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 2040-2(Dec. 1967). (In Russian).

The effects of irradiation with visible light, $^{137}Cs$ gamma rays, and 15-MeV electrons on the absorption spectra of LiH crystals containing different concentrations of defects, and the effect of proton irradiation on the luminescence spectra of luminescent LiH crystals were investigated. Some crystals (sound crystals) were carefully prepared and slowly cooled; other crystals (defective crystals) were quenched from 650°C or contaminated with Mg, Sn, O, or an excess of Li, in order to produce in them a high concentration of defects. The defective crystals were rapidly colored by exposure to visible light, gamma radiation, or high-energy electrons, whereas the sound crystals were colored much more slowly or not at all. These results are regarded as confirming the earlier conclusion of B. L. Dvinyaninov and F. F. Gavrilov that coloring of LiH crystals by ultraviolet radiation is due to the presence of defects in the crystal. Similar behavior under electron bombardment was observed in LiF crystals, which, however, did not color so rapidly or so deeply as the LiH crystals. Proton bombardment of luminescent LiH crystals reduced the concentration of the blue luminescence centers and increased the concentrations of the yellow and red luminescence centers. Possible reasons for these effects of proton bombardment are discussed briefly. (ATD)

**46240** ELECTRON MICROSCOPIC INVESTIGATION OF RADIATION-PRODUCED MACRODEFECTS IN ALKALI METAL HALIDE CRYSTALS. Shvarts, K. K.; Ekmanis, Yu. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 2035-9(Dec. 1967). (In Russian).

The production of macrodefects (crystallites, macropores, colloidal particles, and tracks) in alkali metal halide crystals by irradiation in a nuclear reactor and bombardment with $\alpha$ particles and fission fragments was investigated. The discussion is illustrated with eight electron micrograms. Exposure in the reactor to $10^{15}$ thermal neutrons/cm$^2$ led to the appearance on the crystal surface of 100- to 1000-Å-diameter crystallites and approximately 50-Å-diameter macropores. Increasing the exposure in the reactor led to an increase in the area of the surface macrodefects and to the appearance of 0.1- to 1.0-$\mu$-diameter alkali metal particles. Sometimes these colloidal metal particles were directly associated with the crystallites. Although chemical etching will not reveal tracks of even 40-MeV $\alpha$ particles, 200- to 500-Å-wide 1.2-$\mu$-long tracks of 5.5-MeV $\alpha$ particles were revealed by the replica technique. The tracks (about one for every five incident $\alpha$ particles) were nonuniformly distributed over the crystal surface. There was observed a strong effect of moisture in the air on the structure of the tracks. Prolonged exposure of LiF crystals to fission-fragment bombardment in a moist atmosphere led to the appearance of approximately 2-$\mu$-long 600-Å-wide tracks. Different hypotheses concerning the mechanism of the production of macrodefects are discussed briefly. It is suggested that the apparent continuity of the tracks may be a spurious result of diffraction in the electron microscope, and it is concluded that crystallites are the characteristic macrodefect produced by all types of radiation, that the production of crystallites is associated with enhancement of diffusion during the irradiation, that the growth of crystallites plays a definite role in the production of defects in particle tracks, that atmospheric moisture affects the production of defects in tracks, and that the mechanism of the production of macrodefects by radiation is complex. (ATD)

**46241** INVESTIGATION OF ALKALI METAL HALIDE WHISKERS. Gol'denberg, S. U.; Bychkova, A. I.; Melik-Gaikazyan, I. Ya. (Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1964-7(Dec. 1967). (In Russian).

Some results concerning NaCl and KCl whiskers were obtained with microphotometric equipment with which it is possible to measure optical densities of whiskers with diameters down to 10 $\mu$. It was found that the F-band absorption coefficient of NaCl whiskers increases more rapidly under x irradiation and continues to increase at higher doses than does the absorption coefficient of a microscopic surface layer of a macroscopic crystal, and that at a given dose the absorption coefficient is the greater the higher the ratio of the surface of the whisker to its volume. This is regarded as the first direct experimental confirmation of the hypotheses of F. Seitz [(Rev. Mod. Phys., 18: 384(1946)] that the creation of vacancies in a radiation field takes place at the surface of the crystal and at grain boundaries. Annealing the whiskers, as a result of which nearly all the etching pits acquired flat bottoms, increased the rate of accumulation of F centers; this confirms the conclusion reached by several groups of investigators that the presence of dislocations is not necessary for the production of vacancies at room temperature. It was also found that x irradiation increased the microhardness of crystal whiskers more rapidly than it did that of macroscopic single crystals. It is concluded that the large ratio of surface to volume has a significant effect on both the mechanical and radiation properties of crystal whiskers. (ATD)

**46242** COLORING OF LiF CRYSTALS BY HEAVY DOSES OF X RADIATION. Alekseeva, E. P. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1958-61(Dec. 1967). (In Russian).

The coloring of LiF crystals by the action of x rays from a tungsten target bombarded with 40-keV electrons was investigated. Four stages of the coloring process were distinguished: (1) The first stage (light dose) was a period of weak coloring when mainly F centers were produced. In this stage the growth of the F-center concentration was due mainly to the presence in the crystal of bundles of vacancies. (2) With further irradiation there appeared M and R centers in addition to the F centers. In this stage there could be observed and studied the mutual transformation of F, M, and R centers into each other. The thermostimulated luminescence of irradiated crystals to which no activator had been added exhibited bands at 3400 and 4800 Å; the nature of the centers responsible for this luminescence is not known. (3) After still further x irradiation there appeared N centers, the concentration of which could be increased at the expense of the R- and M-center concentration by illuminating the crystal with R or M light and annealing at 220°C. Annealing at 320°C reduced the N-, M-, and R-center concentrations and caused the appearance of a new absorption band at 4950 Å, the disappearance of the 3400 Å luminescence, and the appearance at 6700 Å of a new luminescence band that was not due to M centers. In this stage the crystals exhibited more etching pits than they did in the earlier stages, and prolonged anneal at 320°C led to a decrease in the number and an increase in the size of the etching pits and the appearance of small black spots. (4) After heavy doses of x radiation the F centers were destroyed in the process of excitation, the M, R, N, and 4950 Å bands broadened and overlapped each other, there appeared new absorption bands at 7600 and 9500 Å, which have been ascribed to $R'(F_3)$ and $M'(\overline{F_2})$ centers by D. B. Fitchen (Internat. Conf. Luminescence, Budapest, C5: 57(1966)), and in the thermoluminescence spectrum there appeared bands at 5300 and 6700 Å. At this stage the etched crystals revealed pyramids due, apparently, to etching of new dislocations, and flat-bottomed rectangular figures due to etching of short glide bands. Micrographs also revealed the presence of precipitate particles along the glide bands. The results are discussed briefly. It is hypothesized that in the heavily irradiated crystals the F centers diffuse through the crystal and combine with $Li^+$ ions to form Li atoms, which distort the lattice, decorate dislocations not previously manifest, give rise to the 4950 Å absorption and the 6700 Å emission, and constitute the precipitate. It is suggested that the 4950 Å band should be regarded as a precursor of colloid formation. (ATD)

**46243** VACANCIES IN IRRADIATED LITHIUM FLUORIDE CRYSTALS. Vorozheikina, L. F.; Igitkhanishvili, D. D. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1940-2(Dec. 1967). (In Russian).

The temperature dependence from room temperature to 400°C of the electric conductivity of LiF crystals irradiated in the column of a nuclear reactor was investigated. During the resistivity measurement the temperature of the specimen was steadily raised at the rate of 1°C per minute. The unirradiated crystals exhibited four temperature regions, bounded by temperatures of approximately 100, 200, and 250°C, within each of which the activation energy for the charge carriers was approximately constant. The activation energies in the four regions (in order of increasing temperature) were, for example, 1.1, 0.92, 0.51, and 1.36 eV for one specimen. Repeated measurement, involving repeated heating to 400°C, did not alter the conductivities of the unirradiated specimens. Irradiating a crystal with $3.6 \times 10^{15}$ neutrons/cm$^2$ raised the conductivity by a factor of 2.3 (at 78°C), and repeated measurement (i.e., repeated heating) led to further increase of the conductivity, the conductivity measured during the third run being some 300 times greater than that measured during the first run. The effect of annealing at different temperatures on the conductivity of irradiated crystals was investigated. It was found that annealing at 190 to 200° and at 280° increased the conductivity, the increase being the greater, the longer the anneal, whereas annealing at other temperatures did not affect the conductivity. The conductivity of the crystals increased with increasing irradiation up to a dose of $3.6 \times 10^{15}$ neutrons/cm$^2$, and decreased with further irradiation. It is concluded that annealing an irradiated LiF crystal at 190 to 200° results in the injection into the lattice of an enormous number of cationic vacancies arising from the healing of radiation defects, and that the effect on the conductivity of annealing at 280° is due to healing of dislocations. (ATD)

**46244** INFLUENCE OF STRUCTURE DEFECTS ON THE HEAT CONDUCTIVITY OF LITHIUM FLUORIDE CRYSTALS. Kvachadze, V. G.; Politov, N. G. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1936-7(Dec. 1967). (In Russian).

The heat conductivities of LiF crystals were measured at temperatures from 90 to 200°K before and after the crystals had been irradiated in a reactor with $1.6 \times 10^{16}$ neutrons/square centimeter. Irradiation considerably reduced the heat conductivity of the crystals, and it was found that the lower the temperature of the crystal during irradiation, the lower the heat conductivity of the irradiated crystal (crystals were irradiated at temperatures of 310 and 140°K). Crystals from two different sources that had initial dislocation concentrations $2.7 \times 10^4$ and $2.3 \times 10^5$ cm$^{-2}$, respectively, had equal heat conductivities before irradiation, but after irradiation at 140°K the crystals with the higher initial dislocation concentration had the higher heat conductivity. It is suggested that irradiation reduces the heat conductivity of the crystals by producing point defects within them and that the effect is more marked in cold crystals than in warm ones because warm crystals lose point defects by coagulation and attachment to dislocations more rapidly than do cold crystals. It is concluded that dislocations play a role in the reduction of the heat conductivity under irradiation even at temperatures at which dislocations cannot effectively scatter phonons. (ATD)

**46245** DISLOCATIONS AND OPTICAL PHENOMENA IN IONIC CRYSTALS. Politov, N. G. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1926-35(Dec. 1967). (In Russian).

The experimental progress achieved and the theoretical concepts advanced concerning the production of color centers in ionic crystals and, in particular, their relation to dislocations, since the publication in 1954 of Seitz' mechanism for the production of vacancies in crystals by the action of radiation are reviewed. A rather large body of information concerning changes in the dislocation density in crystals by the action of radiation has been accumulated; considerable attention is given in the review of these findings and to the theoretical concepts to which they have given rise. It is suggested that the nonmonotonic dose dependence of the lattice constant of annealed LiF crystals under neutron irradiation found by K. Kubo and H. Motohashi [J. Phys. Soc. Japan, 18: 1694(1963)] may be due to condensation of Frenkel point defects into dislocations, rather than to the presence of internal stresses, as suggested by Kubo and Motohashi. Work with which the author was associated has shown that when LiF crystals are irradiated with thermal neutrons at ordinary temperatures (but not when the crystals are sufficiently cooled during irradiation), both the absorption coefficient of the crystal and the dislocation density within it depend nonmonotonically on the dose, the dislocation density tending to be minimum for doses for which the absorption coefficient is maximum. It is suggested that there may take place a periodic process in which the crystal becomes saturated with point defects, the point defects condense to form dislocations, the dislocations decay, more point defects are formed, and the process repeats. (ATD)

**46246** ION-BOMBARDMENT INDUCED DAMAGE IN DIAMOND LAYERS. Galkin, V. V.; Guseva, M. I.; Krasnopevtsev, V. V.; Milyutin, Yu. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 10: 706-8(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 902-5(Mar. 1968).

Diamond plates with lapped faces parallel to the (111) plane, were bombarded with $^7Li$, $^{11}B$, and $^{31}P$ ions in the $\langle 111 \rangle$ direction at 20 to 120 keV energy and $10^{14}$ to $10^{16}$ cm$^{-2}$ doses. The depths of the damaged regions were measured using reflected light spectra relative to unirradiated samples. The spectra show two systems of equidistant interference maxima. It is concluded that the bombardment results in two damaged layers, the deeper layer having more damaged structure than the first. The thickness of the first layer increases with energy and decreases with dose, and the total thickness increases at a lower rate with energy. (D.L.C.)

**46247** FORMATION MECHANISM OF LATTICE DEFECTS AND F CENTERS BY ELECTRONIC SUBSYSTEM EXCITATION. Vinetskii, V. L. (Inst. of Physics, Kiev). Sov. Phys.-Solid State (Engl. Transl.), 10: 680-5(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 867-75(Mar. 1968).

The thermal formation probability of lattice defects (for example, Frenkel defects) is considered with the assistance of electronic excitation by a free electron or hole, an electron-hole pair, or an exciton which becomes located at the level of the nascent defect during the formation process. This probability, in accordance with the detailed equilibrium principle, is connected with the defect annihilation probability and can be determined in the simplest case from elementary considerations. It is shown that the defect formation probability aided by free electrons (holes) may be high at room and lower temperatures for actual values of crystal parameters. For example, the optical excitation of electrons from donor levels to the conduction band can lead to the formation of an appreciable number of lattice defects, provided that the ionizing radiation is sufficiently intense (easily achievable with suitable parameter values). The problem of explaining F-center creation, under the action of x rays, is also discussed in

terms of thermal formation of Frenkel defects aided by the electron-hole pairs or excitons generated by x radiation. (auth)

**46248** INFLUENCE OF THE CRYSTAL STRUCTURE ON THE LOSS OF ENERGY BY FAST PROTONS IN SINGLE CRYSTALS OF ALKALI HALIDES. Shipatov, E. T.; Kononov, B. A. (Tomsk Polytechnical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 670-2(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 854-7(Mar. 1968).

A study was made of the effect of orientation on the loss of energy by 6.72-MeV protons in alkali halide single crystals. The energy spectra of protons were recorded after passage through NaCl (17.3 mg/cm$^2$) and KBr (4.12 mg/cm$^2$) single crystals along directions inclined at various angles to the principal crystallographic direction ⟨100⟩ of these crystals. It was found that the average energy losses decreased when the beam direction coincided with the ⟨100⟩ axis. The results obtained were analyzed from the point of view of the influence of the crystal lattice on the passage of charged particles through solids. (auth)

**46249** SMALL HYPERFINE FIELD AT CESIUM NUCLEI IN IRON. de Waard, H.; Drentje, S. A. (Univ. of Groningen, Netherlands). pp 510-14 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The hyperfine field at cesium nuclei in iron was investigated by observing the Moessbauer effect on the 81-keV transition of $^{133}$Cs, excited in the decay of $^{133}$Xe nuclei implanted in the iron by a mass separator. The measurement yields $|H| < 24$ kOe. The isomer shift indicates that the cesium atoms are properly bound in the iron lattice. (auth)

**46250** ON THE POSSIBILITY OF A MAGNETICALLY INDUCED QUADRUPOLE INTERACTION IN $FeCr_2S_4$. Hoy, Gilbert R.; Singh, K. P.; Chandra, Subhas (Boston Univ.). pp 515-19 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Moessbauer studies as a function of temperature were performed with the normal spinel $FeCr_2S_4$. Although this material is cubic, a quadrupole interaction appears below the transition temperature. The effective internal magnetic fields and electric field gradients at the $^{57}$Fe nuclei were determined at 77, 89, 113, 122, and 140°K. The relative orientation of the internal magnetic field with respect to the principal axes of the electric field gradient tensor was also determined. These experimental results are compared with predictions made using a straightforward model of a magnetically induced quadrupole interaction. The theoretical predictions are at odds with the experimental results. (auth)

**46251** MOESSBAUER STUDY OF THE HYPERFINE FIELDS IN Zn-Mn FERRITES. Cser, L. (Central Research Inst. for Physics, Budapest); Dezsi, I.; Keszthelyi, L.; Kulgawczuk, D.; Eissa, Nabil A.; Sterk, A. pp 520-4 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The hyperfine field in $Mn_{1-x}Zn_xFe_2O_4$ ferrites was studied as a function of x and the temperature. A model employing six nearest neighbors, which was used to evaluate the Moessbauer spectra, furnished convex magnetization functions if the number of Zn nearest neighbors was ≥3. (auth)

**46252** MAGNETIC HFI OF THE 4+ STATE IN $^{166}$Er SITUATED IN HoIG. Koicki, A.; Koicki, S. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). pp 525-8 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The rotation of integral angular correlation in $^{166}$Er, built into HoIG, was measured at 300 and 85°K. The attenuation factors, internal magnetic fields, exchange field, and relaxation times were determined and are discussed. The internal field is found to be of opposite sign at two temperatures. (auth)

**46253** MOESSBAUER EFFECT STUDY OF CRITICAL BEHAVIOR IN IRON FLUORIDES. Wertheim, G. K.; Guggenheim, H. J. (Bell Telephone Labs., Murray Hill, N. J.). pp 531-48 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect of $^{57}$Fe was used to measure the temperature dependence of the sublattice magnetization just below the Néel point in fluorides having rutile, cubic perovskite, and rhombohedral structures. Data in region $0.9\ T_N < T < T_N$ are analyzed in terms of the equation $M(T) = M_0D(1 - T/T_N)^{\beta}$, in which the critical exponent $\beta$ is of greatest theoretical interest. In all cases the experimental values are close to the exponent calculated for a three-dimensional Heisenberg ferromagnet, and quite distinct from that given by the classical molecular field approach. Comparison of results in $FeF_2$ with those obtained by NMR in $MnF_2$ shows no significant difference in the critical exponent even though the temperature dependence of the magnetization in the two are quite distinct. In $FeF_3$ the exponent is close to that in $CrBr_3$. Cubic perovskites such as $RbFeF_3$ exhibit more complex behavior due to degeneracies in the crystal field levels which are lifted both by strain and by magnetic interactions. (auth)

**46254** HYPERFINE STRUCTURE COUPLING TO $^{197}$Au IN $Au_2Mn$ AS A FUNCTION OF PRESSURE. Thomson, J. O.; Huray, Paul G.; Patterson, D. O.; Roberts, Louis D. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). pp 557-65 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect was used to study the pressure dependence of the hfs of $^{197}$Au at 4.2°K in the helical antiferromagnet $Au_2Mn$. The hfs can be described in terms of an effective magnetic field, H, a quadrupole coupling with principal axis perpendicular to H, and a charge polarization factor $\overline{P} = |\psi^2_{alloy}(0)|/|\psi^2(0)_{Au\ metal}|$. The $\overline{P}$ is obtained from the Moessbauer effect isomer shift through a relation derived earlier by measurements of the isomer shift as a function of pressure for Au metal and by a correlation of the isomer shift with residual electrical resistance for alloys dilute in Au. For $Au_2Mn$ at 0 pressure, $\overline{P} = 1.35$, H = 1571 kG and eqQ = 2.705 ± 0.070 mm/sec are obtained. As the pressure is increased to 30 kbars, $\overline{P}$ increases approximately 2%, the same order of magnitude as the density change of the alloy, and eqQ does not change, within experimental error. On the other hand, H increases by approximately 8% over this pressure range, remaining roughly constant between ≈30 and 46 kbars. This behavior is attributed to the uncoiling of the spiral spin structure of the alloy. (auth)

**46255** INVESTIGATION OF CONDENSED AQUEOUS SYSTEMS BY MOESSBAUER EFFECT. Dezsi, I.; Keszthelyi, L.; Molnar, B.; Pocs, L. (Central Research Inst. for Physics, Budapest). pp 566-95 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Solidified solutions of various $^{57}$Fe ions in high-spin states were investigated by measuring their Moessbauer spectrum. The close values of the quadrupole splitting and the isomeric shift obtained at −191°C are an indication of the similar symmetries around these ions at this temperature. The temperature dependence of the Moessbauer parameters—namely, intensity, quadrupole splitting, and line width, exhibits a remarkable change at about −90°C in the solid solutions under investigation, except for that of Mohr salt, for which this change occurs at −62°C. For the pure crystalline hydrates of dissolved iron salts, no similar change takes place. The change in the temperature behavior suggests that a structural transformation occurs at this temperature, probably recrystallization, involving a violent atomic diffusional motion. This conjecture is supported by the finding that the isothermal time behavior of the changes observed is similar to the S-shaped curve obtained by other methods for structural transformations. (auth)

**46256** HYPERFINE STRUCTURE IN Tm METAL BELOW THE NEEL TEMPERATURE. Cohen, R. L. (Bell Telephone Labs., Murray Hill, N. J.). pp 602-4 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Moessbauer effect measurements of the hyperfine structure of $^{169}$Tm below the Néel temperature are presented and analyzed. The interpretation is based on the neutron-diffraction analysis of the magnetic structure and assumes fast relaxation among the exchange-split levels of the lowest J multiplet. The assumption of slightly incommensurate magnetic and crystal unit cells is used in the successful interpretation of the data, since it produces a continuous distribution of hyperfine fields, as is observed. (auth)

**46257** COMPARABILITY OF INTERNAL FIELDS MEASURED IN ALLOYS PREPARED BY ION IMPLANTATION AND BY MELTING OR DIFFUSION. Reid, P. G. E. (Oxford Univ.); Sott, M.; Stone, N. J.; Spanjaard, D.; Bernas, H. pp 719-26 of Hyperfine

Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Nuclear orientation measurements are reported on $^{198}$Au and $^{122}$Sb in <0.1 at.% alloys of Au and Sb respectively in Fe, prepared both by diffusion and by implantation, using an isotope separator. It is shown that although it is possible to obtain the same hyperfine interaction by using both methods of source preparation, in general the implanted sources give a reduced effect. The sensitivity of the technique and the doses and annealing behavior on the implanted sources are discussed. (auth)

**46258** MAGNETIC HYPERFINE FIELDS. Freeman, A. J. (Northwestern Univ., Evanston, Ill. Massachusetts Inst. of Tech., Cambridge). pp 427-49 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Developments in the theory of magnetic hyperfine interactions over the past few years are reviewed for free ions and atoms, magnetic and diamagnetic ions in compounds, and conduction-electron effects in metals and alloys. In each area the various contributions to the hyperfine field are discussed with emphasis on the present theoretical understanding. Where possible, systematics in both theoretical calculations and experimental data are noted and commented upon. Finally, several areas of potential interest to experimentalists concerned with techniques based on the detection of nuclear radiations are indicated, including the study of superconductors, localized moments in metals and the effect of a Kondo ordered state on observed hyperfine interactions and the enormous hyperfine fields ($10^8$ to $10^{11}$ gauss) which exist following K (or L) capture or are induced by external means. (auth)

**46259** INTERNAL FIELDS IN FERROMAGNETICS. Daniel, E. (Institut de Physique, Strasbourg). pp 450-62 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Several experimental techniques, such as Mössbauer effect, angular correlations of $\gamma$ rays, nuclear magnetic resonance, nuclear specific heat, etc. permit measurement of the internal field (hyperfine field) responsible for the alignment of nuclear spins on the magnetization in simple ferromagnetics. Even if contributions to the internal field other than contact interactions are negligible, a theoretical analysis of the measured field is especially difficult in metallic materials, because of the double origin of these contact terms: spin polarization of the core electrons via the magnetic shells, and spin polarization of the conduction electrons. Theoretical models used to describe the distribution of charge and spin densities in metallic alloys are presented in order to allow some analysis of the internal fields measured in metallic ferromagnetics. Recent experimental results concerning Ni- and Fe-based alloys, fields in Heusler alloys and on nonmagnetic impurities in Fe are discussed with special stress on the contribution due to conduction electrons. (auth)

**46260** SPIN AND CHARGE DENSITY IN Eu-Yb ALLOYS. Huefner, S.; Wernick, J. H. (Bell Telephone Labs., Murray Hill, N. J.). pp 463-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect of the 21.7-keV $\gamma$ line of $^{151}$Eu was employed to study the isomer shifts and the magnetic fields in some Eu-Yb alloys. The isomer shift stays constant for all compositions whereas the magnetic field shows approximately a linear decrease with increasing Yb content. (auth)

**46261** TEMPERATURE INVERSION OF THE INTERNAL MAGNETIC FIELD ON $^{169}$Tm IN GdIG. Koicki, S.; Koicki, A. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). pp 467-70 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The rotation of integral angular correlation in $^{169}$Tm built into GdIG (gadolinium iron garnets) was measured as a function of temperature (0 to 35°C). The internal field of about 200 kG at $^{169}$Tm is completely inverted in direction in the short temperature interval of some 10°C, in the vicinity of the compensation point of GdIG. The temperature hysteresis of the internal field is observed. The "coercive temperature" is found to depend on the strength of the applied magnetic field. The phenomena are briefly discussed. (auth)

**46262** MAGNETIC HYPERFINE FIELD AT THE PALLADIUM NUCLEI IN IRON. Johansson, K.; Karlsson, E.; Norlin, L. O.; Tandon, P. N.; Jain, H. C. (Univ. of Uppsala). pp 471-9 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The magnetic hyperfine interaction in palladium dissolved in iron was studied with the integral PAC (perturbed angular correlation) method by use of the 624-512 keV cascade in $^{106}$Pd. The value of the hyperfine field, $-584 \pm 63$ kG, obtained by comparison with the interaction strength in a known external field, was found to be in agreement with the result obtained by spin-echo NMR at 4.2°K. The source preparation is discussed as well as the effect of different polarizing fields. It was found that the saturation value of the effective field was reached only when relatively high polarizing fields were used for the present type of diffused sources. The temperature dependence of the hyperfine field was measured from 4.2 to 1123°K. The $B_{hf}$ vs T curve was found to follow the magnetization curve of bulk iron except for a dip in the region around 0.5 to 0.6 $T_c$. This effect might indicate a small localized moment contribution to the hyperfine field for Pd in Fe. (auth)

**46263** ANGULAR CORRELATION STUDIES OF CADMIUM AND RUTHENIUM IN NICKEL. Shirley, D. A.; Rosenblum, S. S.; Matthias, E. (Univ. of California, Berkeley). pp 480-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Experimental studies of the hyperfine fields at nuclei of $^{111}$Cd and $^{99}$Ru in an Ni lattice are described. Measurements were made from 4°K to above the Curie temperature by the use of the method of time-dependent perturbed angular correlation. (D.C.W.)

**46264** MOESSBAUER EFFECT STUDIES ON BINARY IRON-TIN ALLOYS. Both, E. (Technical Univ., Lyngby, Denmark); Trumpy, G.; Traeff, J.; Oestergaard, P.; Djega-Mariadassou, C.; Lecocq, P. pp 487-94 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

In order to study possible regularities among hyperfine fields in binary iron-tin alloys, a Moessbauer effect study was performed on the intermetallic compounds $Fe_3Sn$, $Fe_5Sn_3$, $Fe_3Sn_2$, FeSn, and $FeSn_2$, as well as on solid solutions of tin in iron metal. Also, the magnetic moment per iron atom was measured for the ferromagnetic compounds. The results are compatible with the assumption that the 3d electron band has roughly the same population for all these compounds, and its polarization is the same for all the ferromagnetic alloys. From the isomer shifts, one can roughly deduce a standard value for the reduction of the s-electron density at the nuclei for each Fe-Sn metallic bond. (auth)

**46265** INTERNAL FIELD OF TANTALUM NUCLEI IN NICKEL. Vanderleeden, J. C. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. pp 495-7 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The time-differential precession method was used to determine the hyperfine field at the site of tantalum nuclei in a nickel lattice. The observed value is $H_{hf} = -87.9 \pm 2.5$ kG. (auth)

**46266** THE MAGNETIC HYPERFINE FIELD AT Hf NUCLEI IN AN IRON LATTICE. Becker, A. J.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1420. pp 498-502 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The method of spin precession as observed in a time-integrated directional correlation measurement was used to determine the induced magnetic hyperfine field $H_{int}$ acting at Hf nuclei embedded in an iron lattice. The Larmor precession angle of the $^{9}/_{2}^{+}$(208 keV) $^{9}/_{2}^{-}$(113 keV) $^{7}/_{2}^{-}$ $\gamma$-$\gamma$ directional correlation in $^{177}$Hf, using a source of $^{177}$Lu implanted in an iron foil, was measured; from the known g-factor of the 113-keV state of $^{177}$Hf, the magnitude and sign of $H_{int}$ were extracted as $H_{int} = -(300 \pm 60)$ kOe. The influence of quadrupole interactions could not be neglected, and appropriate corrections were applied to the measurements. The

value and sign of $H_{int}$ for Hf in iron agree reasonably well with the empirical systematic trend shown by $H_{int}$ for the 5d transition elements in an iron host. (auth)

**46267** INTERNAL MAGNETIC FIELDS AT Mo, Ru, Pd, Sm, AND Pt NUCLEI IMPLANTED IN Fe, Co, Ni, AND Gd METALS. Murnick, D. (Massachusetts Inst. of Tech., Cambridge); Grodzins, L.; Kalish, R.; Borchers, R. R.; Bronson, J.; Herskind, B. pp 503-9 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The internal magnetic fields at nuclei of isotopes of Mo, Ru, Pd, Sm, and Pt implanted into ferromagnetic hosts were studied by using the ion implantation perturbed angular correlation technique, IMPACT. The magnitudes of the internal fields are found to be approximately proportional to the magnetic moments of the host atoms in Fe, Co, and Ni, indicating that any anomalous fields are also proportional to the host moment. The ratios of the fields reported here also agree quite well with those measured by other techniques and higher impurity concentrations. The sign of the field is negative in Ru, Pd, and Pt, and positive for Sm. The fields acting on the nuclei implanted in Gd below the Curie temperature are positive and equal to about 350 kG for Mo, Ru, and Pd. The field on Sm in Gd is −300 kG and on Pt in Gd is 160 kG. (auth)

**46268** EMISSION PARAMETERS OF FACES OF A NIOBIUM SINGLE CRYSTAL. Protopopov, O. D.; Strigushchenko, I. V. Sov. Phys.-Solid State (Engl. Transl.), 10: 747-8(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 943-5(Mar. 1968).

Thermionic emission parameters (work function $\phi_{hkl}$ and $A_{hkl}$) were measured for the (110), (100), (111), and (116) faces of Nb crystals. The agreement of $\phi_{hkl}$ with expected values is good, but the $A_{hkl}$ values are much less than the theoretical value 120 A $deg^{-2}$ $cm^{-2}$. The anomalous Schottky effect was measured for the (100) and (110) faces. Reasons for the discrepancy of the $A_{hkl}$ values are discussed. (D.L.C.)

**46269** MOESSBAUER MEASUREMENTS FOLLOWING COULOMB EXCITATION AND RECOIL IMPLANTATION. Obenshain, Felix E. (Oak Ridge National Lab., Tenn.). pp 655-74 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Coulomb-excitation Moessbauer experiments do not require that the relevant energy levels be populated by radioactive decay, and in many cases preparation of targets from stable isotopes is much simpler than preparation of radioactive sources. The added feature of Coulomb recoil implantation lends further simplification and at the same time provides a wider selection of host materials for the target nucleus. It has been shown that the target element may be either deposited directly on the host material or separated from it by a distance which depends on the lifetime of the excited state. The elements in the rare earth region are of particular interest for application of the method, since there are many nuclei with levels suitable for Moessbauer experiments, the Coulomb excitation cross sections are large, and, in most cases, the sources are difficult to prepare. An example is the element ytterbium, with seven stable isotopes. All five of the even-even isotopes have been studied by the Coulomb-excitation Moessbauer method and the relative electric quadrupole hyperfine interactions for the various isotopes have been measured. Moessbauer measurements with $^{73}$Ge have been possible only by the Coulomb recoil implantation technique. Here, for example, a choice between two possible spin assignments for the excited state may be made by comparison of experimentally measured and theoretically calculated solid-state properties of germanium. Radiation damage in solids due to charged particles and low concentrations of impurities in solids are two problems that may be studied from a new point of view by Coulomb-recoil implantation Moessbauer experiments. (auth)

**46270** MOESSBAUER EFFECT BY RECOIL IMPLANTATION THROUGH VACUUM. Kalvius, G. M.; Sprouse, G. D.; Hanna, S. S. (Stanford Univ., Calif.). pp 686-98 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect was observed for Coulomb-excited $^{57}$Fe recoils implanted through vacuum into various media [Cu, Al, Au, Fe, Ge, Si, graphite, $Fe_2O_3$, and $(Fe,Mg)_2SiO_4$]. This method avoids heating and radiation damage of the host medium by the beam. Where comparison data are available for Cu, Au, Al, and Fe, the results at room temperature indicate that within the nuclear lifetime of $10^{-7}$ sec the recoils find a normal lattice site. A measurement with Cu at 4°K indicates a similar result. Implantation into Ge and Si showed two reasonance lines. For graphite, $Fe_2O_3$, and $(Fe,Mg)_2SiO_4$ the Moessbauer effect is significantly reduced. The alignment of the nuclear recoils produced in the Coulomb excitation process was observed by detecting the gamma-ray polarization with a Moessbauer polarimeter. The recoil alignment was preserved by introducing He gas into the space traversed by the recoils. (auth)

**46271** INTERNAL MAGNETIC FIELDS OF RARE EARTH IN IRON AND THE LOCATION OF RARE EARTH IMPURITIES IN RELATION TO THE IRON LATTICE. Schmorak, M.; Boegh, E. (Laval Univ., Quebec, Can.). pp 712-18 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The precession of angular correlations in $^{164}$Tm implanted into iron foil is studied. The location of rare earth atoms implanted in iron single crystals is studied by using the channeling effect. About 40% of these atoms are found to be in substitutional positions; the remaining 60% are probably located in radiation-damaged zones of the crystal. (auth)

**46272** MOESSBAUER $^{57}$Fe POLARIMETRY. Gonser, Ulrich (North American Aviation Science Center, Thousand Oaks, Calif.). pp 343-56 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The usefulness of linearly polarized recoil-free $\gamma$ rays in determining spin orientations and principal axes of electric field gradients is demonstrated with the compound $FeCO_3$ (siderite). Magneto optic effects with polarized $\gamma$ rays such as the Faraday effect and magnetic double refraction have been observed in the ferrimagnetic material $MgFe_2O_4$. The arrangement for the Faraday effect does not require any Doppler motion. (auth)

**46273** THE RECOGNITION AND ANALYSIS OF HYPERFINE SPLITTINGS OF DECAYING MOESSBAUER STATES. Albrecht, Klaus; Hauser, Ulrich; Neuwirth, Wolfgang (Univ., Heidelberg). pp 357-63 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

A method for increasing the sensitivity of resonance absorption experiments to find smaller hyperfine splittings is described. The time-dependent resonance absorption is applied to a hyperfine splitting absorber, and the results obtained from an absorber with a small quadrupole splitting are discussed to illustrate the usefulness of this method. (auth)

**46274** IMPLANTATION AND DETECTION OF LOW ENERGY ARGON IONS IN SILICON SINGLE CRYSTALS. Comas, James; Carosella, Carmine A. (Naval Research Lab., Washington, D. C.). J. Electrochem. Soc., 115: 974-6(Sept. 1968).

One of the present problems in construction of a consistent sputtering model is to determine the fate of the bombarding species. Thermal desorption or resputtering the target with a different gas and recording the release of the first bombarding species with a mass analyzer are the methods usually employed. This paper reports on a method of bombarding silicon with argon ions in the 100- to 2200-eV range and detection of the implanted species in situ. The detection procedure involves activation analysis of the targets, first exposing them to a reactor neutron flux of $10^{13}$ n/sec for 1 hr; $^{41}$Ar, which emits a 1.293-MeV gamma ray, is produced and detected by means of a lithium-drifted germanium detector used in conjunction with a multichannel analyzer. (L.M.T.)

**46275** THE RELATIVE DIFFERENCE IN THE IONIC MOBILITIES OF LITHIUM $^6Li^+$ AND $^7Li^+$ ISOTOPES IN LiF SINGLE CRYSTALS. Ptashnik, V. B.; Naumov, A. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 690-3(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 880-4(Mar. 1968).

A method of determining the isotope effect in self-diffusion, based on measurements of the relative difference in isotope mobilities in ionic crystals, is considered. Equations are given which allow this relative difference in isotope mobility $\Delta\mu/\mu$ to be determined for two cases: 1) isotope concentration measurement in layers:

$$\frac{\Delta\mu}{\mu} = \frac{(n_2 - n_{20})\sqrt{\pi D}}{2\sqrt{t}\,\mu t_+ n_1 (1 - n_1) E \left\{\exp(-z^2) - z\sqrt{\pi}\,\mathrm{erfc}\,(z)\right\}};$$

2) measurement of the difference between the mean isotope concentration in the anode section of the crystal and the original isotope concentration in the crystal:

$$\frac{\Delta\mu}{\mu} = \frac{m\Delta n_i F}{2qt_+n_i(1-n_i)\,M\left\{\mathrm{erf}(Z)\,[Z^2+(1/2)]-Z^2+(1/\sqrt{\pi})\,Z\exp(-Z^2)\right\}}$$

The relative difference in the ionic mobilities of $^6Li^+$ and $^7Li^+$ isotopes were measured in LiF single crystals in the temperature range 600–750°C. The quantity $\Delta\mu/\mu$ increased from 0.0325 to 0.0360 with rising temperature. The isotope effect for lithium self-diffusion in LiF, calculated from the mean value of $\Delta\mu/\mu$, was E = 0.42. (auth)

**46276** MAGNETIC PROPERTIES OF THE US–ThS SYSTEM. Chechernikov, V. I.; Shavishvili, T. M.; Pletyushkin, V. A.; Slovyanskikh, V. K.; Ellert, G. V. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 54: 1715-19(June 1968). (In Russian).

Magnetic properties of alloys of the US–ThS system were studied throughout the complete concentration range. Alloys containing up to 60 at. % of ThS are ferromagnets. In magnetic fields up to 7 kOe the magnetization is not saturated. In the paramagnetic region the magnetic susceptibility obeys the Curie–Weiss law. The effective magnetic moment $\mu_{eff}$ per uranium atom increases with growth of the ThS content up to 3.6 $\mu_B$ for alloys with 90% of ThS. In all alloys the paramagnetic Curie temperature $\Theta_p$ is positive and vanishes with increase of the ThS content. According to x-ray structure analysis, all alloys obtained possess a NaCl-type structure and are solid solutions, the lattice constant a increasing with increase of the ThS content. (auth)

**46277** INTERPRETATION OF THE ISOMER (CHEMICAL) SHIFT OF THE MOESSBAUER ABSORPTION SPECTRA FOR $^{119}Sn$ AND $^{197}Au$ IMPURITY NUCLEI IN METALLIC MATRICES. Chekin, V. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 54: 1829-33(June 1968). (In Russian).

Isomer shifts for the $^{119}Sn$ and $^{197}Au$ impurity atoms are considered on basis of the Goodings–Mozer formula expressing the charge density on impurity nuclei in metals in terms of the state density of a nonperturbed matrix and of the magnitude of the perturbation. In the first case the variation of the isomer shifts may be explained on basis of the assumption of an appreciable localization of the 5s level in the impurity position. In both cases the role of the difference of the impurity-matrix valencies is greater than the density of the unperturbed matrix states. (auth)

**46278** ELECTRON SPIN RESONANCE OF PARAMAGNETIC TUNGSTEN AND NIOBIUM SUBSTITUTION IN CALCIUM TUNGSTATE. Chu, Keh-chang. Ann Arbor, Mich., Univ. of Michigan, 1967. 110p.

Thesis.

The electron spin resonance (ESR) spectra of specific calcium tungstate crystals after reactor-neutron or cobalt-60 gamma irradiation were investigated. Pure calcium tungstate crystals after reactor-neutron irradiation of $10^{17}$ nvt show many ESR lines at room temperature and liquid nitrogen temperature. Two prominent groups of lines are identified as paramagnetic tungsten associated with calcium and oxygen vacancies respectively. Uniaxial stress experiments provide further support to this assignment. The measured number of oxygen vacancies is found to be in good agreement with the theoretical treatment of Kinchin and Pease. Niobium-doped calcium tungstate crystals after cobalt-60 gamma irradiation of $10^6$ rads show prominent ESR lines at 77°K and 195°K. The spectrum is due to paramagnetic niobium at tungsten sites. At 195°K, the spectrum is of axial symmetry with $g_{||} = 2.023$, $g_{\perp} = 2.026$, A = 29.0 gauss, and B = 29.2 gauss, where the symmetry axis is along the crystal co-axis. As the temperature decreases the spectrum is broadened at first and finally splits into four at 77°K. The average position of the low-temperature spectrum is equal to the position of the high-temperature spectrum This temperature dependence is explained in terms of vibronic interaction. (TSS) (Diss. Abstr.)

**46279** RECOMBINATION LUMINESCENCE IN IRRADIATED SILICON. Spry, Robert James. Urbana, Ill., Univ. of Illiinois, 1967. 163p.

Thesis.

Radiative recombination of optically injected carriers has been observed in $^{60}Co$ gamma-ray- and fast-neutron-irradiated float-zone grown and pulled silicon. At liquid helium temperature, a complex spectrum, including a very intense band at 0.971 eV, is found in both n- and p-type float-zone material. There is an additional similar complex spectrum in both n- and p-type pulled crystals, including a very intense band at 0.791 eV. Both of these intense bands have thermally broadened halfwidths about equal to kT. Much of the two portions of the spectra may be replicated by displacing either one by 0.180 eV toward the other. The major features of both spectra are independent of type and amount of III–V doping impurities, type of radiation, and amount of irradiation up to integrated fluxes of $10^8$R of gamma rays and $10^{14}/cm^2$ fast neutrons. The defect associated with the lower energy spectrum is dependent upon oxygen for formation and anneals at room temperature, while the defect associated with the higher energy spectrum is stable at room temperature. An additional band associated with a third defect is found at 0.794 eV in gamma-irradiated pulled crystals three days after irradiation, but anneals away within 5 days after irradiation. Measurements of the luminescence at liquid nitrogen temperature are consistent with those at liquid helium temperature. It is suggested that the luminescence of the two major portions of the spectra are due to the recombination of free holes and trapped electrons in the ground states of two different defects, 0.194 eV and 0.374 eV below the conduction band minima. The two very intense bands occur without phonon cooperation, while the other bands in the spectra are due to transitions occurring with phonon emission. (Diss. Abstr.)

**46280** SCATTERING OF SLOW NEUTRONS BY THE PROTONS IN HYDROGEN BONDS USING THE DOUBLE-POTENTIAL-WELL MODEL. Stamenkovich, S. S. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 675-9(Sept. 1968).

Translated from Fiz. Tverd. Tela, 10: 861-6(Mar. 1968).

The elastic and inelastic scattering cross sections for neutrons scattered by materials having hydrogen bonds of the type A–H...B are calculated with a double-potential-well model. (auth)

**46281** COLOUR CENTRES IN NEUTRON-IRRADIATED MAGNESIUM OXIDE. King, R. D. Reading, Eng., Univ. of Reading, 1967. 141p.

Thesis.

The object of the study described was to investigate the many optical absorption bands produced by neutron irradiation of magnesium oxide. A close correlation was found between the electron spin resonance F-center signal and an optical absorption band at 5.0 eV. This is consistent with calculations by Kemp and Neeley (Phys. Rev. 132: 1(1963) and Bull. Amer. Phys. Soc. 8: 484(1963)). Assuming that the 5.0-eV band is due to the F center, then the oscillator strength is about 0.7. The F-center concentration reaches a maximum at a dose of ~$10^{19}$ nvt (>1 MeV) and in the same dose region new optical absorption bands appear. Similar bands are seen following heat treatment of crystals irradiated to lower doses, and it seems likely that these bands are due to aggregation of F centers. At low temperatures sharp "zero-phonon" lines are observed on the low-energy side of these bands in a similar manner to those observed on F-aggregate bands in the alkali halides. Splittings of the zero-phonon lines were obtained by applying uniaxial stress to the crystals, and the results were interpreted in terms of the orientational and electronic properties of the defects. The symmetries and electronic properties of the defects associated with the lines are as follows: 4687-, 4703-, and 6704-Å orthorhombic I centers (with electric dipole moments along ⟨110⟩); 5248-Å trigonal E → A; 6423- and 6493-Å trigonal A → E; 7060-Å monoclinic I (with electric dipole moment along ⟨112⟩). It is proposed that the orthorhombic I centers are "M-like" (two F centers along ⟨110⟩), but that one of the two defects associated with the 4687- and 4703-Å lines may also involve an impurity. The trigonal centers are probably "R-like" centers (three F centers in a ⟨111⟩ plane) containing 5, 6, and 7 electrons, respectively. Optical bleaching of zero-phonon lines was observed and this is explained in terms of electron transfer between the various M- and R-like centers containing different numbers of electrons. An emission spectrum was recorded from the R-like center with a zero-phonon transition at 6493 Å. Optical bleaching was also observed for the $F_2$ center (the current model being an F center associated with a cation vacancy along a ⟨100⟩ direction) at an energy of 3 to 4 eV, and this is believed to be due to the removal of an electron from a single bound state of the defect to the conduction band. Although a number of intrinsic defect models have been proposed, the possibility of extrinsic effects cannot be ruled out, particularly in view of the high level of impurity in currently available magnesium oxide. (auth) (UK)

**46282** ANNUAL REVIEW OF NMR SPECTROSCOPY. VOLUME 1. Mooney, E. F. (ed.) London, Academic Press, 1968. 353p. 95s.

The review, covering 1966 and early 1967, is presented under the following main headings: General review of proton magnetic resonance; nuclear magnetic resonance spectroscopy in conformation analysis; interpretation of high resolution nuclear magnetic resonance spectra; heteronuclear magnetic double resonance; nuclear magnetic resonance spectra of polymers; signal-to-noise enhancement of nuclear magnetic resonance spectra; fluorine-19 nuclear magnetic resonance spectroscopy. (UK)

**46283** RECOMBINATION RADIATION OF PURE SILICON AT A HIGH EXCITATION LEVEL. Vavilov, V. S.; Nolle, E. L. Fiz. Tekh. Poluprov., 2: 742-3(May 1968). (In Russian).

Recombination radiation of pure silicon excited by 90-keV electrons with current density from $2 \times 10^{-2}$ to 15 A/cm² was

measured at 80°K. Studies of spectra and relaxation emission showed that at $n_e r_e^3 < 1$ ($n_e$ is concentration and $r_e$ is radius of excitons) the recombination of nonequilibrium carriers in pure silicon take place in exciton stages. In such a case an ordinary single-electron approximation for the semiconductor zone scheme may be utilized. At higher excitation levels the excitation state disappears, the energy zones changing due to the interactions between the carriers. A multielectron problem could explain the changes of the energy spectra but such a problem poses many difficulties. (R.V.J.)

**46284** REACTOR IRRADIATION EFFECTS ON THERMOELECTRIC MATERIALS. Polishchuk, V. F.; Bubyreva, N. S.; Rozenblyum, N. D. Fiz. Tekh. Poluprov., 2: 707-13(May 1968). (In Russian).

Neutron- and γ-radiation effects on electric conductivity, thermoelectromotive force, and resistance to compression were studied using semiconductor materials with germanium telluride base alloyed with bismuth and copper. Data obtained showed that electric conductivity of specimens irradiated with neutron flux $(3 \text{ to } 5) \times 10^{13}$ n/cm² sec reduced the electric conductivity about ten fold, compared to the nonirradiated specimens, while the thermal emf remained unchanged. Irradiation with γ quanta resulted in increased hardness of the specimens with compression increase about two fold, and more at integral doses of 2000 Mrad. (R.V.J.)

**46285** ADSORPTION STUDIES BASED ON THERMIONIC EMISSION MEASUREMENTS. II. OXYGEN ON SINGLE-CRYSTAL TUNGSTEN. Engelmaier, W.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). Surface Sci., 11: 370-94(Aug. 1968).

A simplified version of the cylindrical thermionic emission microscope has been used to investigate the adsorption and desorption of oxygen on a single-crystal tungsten filament. Data are presented for the dependence of the effective work functions of the (100), (110), (111), and (112) crystallographic directions on oxygen pressure and filament temperature in the range $1 \times 10^{-9} - 5 \times 10^{-6}$ torr and 1900–2200°K. The data for each crystallographic direction may be correlated quite well by means of the parameter $T/T_R^*$, where T is the filament temperature and $T_R^*$ is the saturation temperature corresponding to the oxygen pressure. In an attempt to determine the oxygen desorption energies for the various crystallographic directions, the rate of change of thermionic emission was measured following a sudden change in filament temperature and/or oxygen pressure. It is concluded that this technique does not yield the true desorption energy for individual crystallographic directions because of surface migration of oxygen between patches. The apparent desorption energies for the different directions are approximately equal, the average value being ~5.9 eV (~135 kcal/mole). The work functions of the various directions were measured in vacuum ($<1 \times 10^{-9}$ torr) both before and after the filament was exposed at 2200°K to oxygen at $1 \times 10^{-6}$ torr for 63 hours. Since this exposure did not produce significant changes in the work functions, it is concluded that (i) the concentration of carbon impurities in the filament was not sufficient to affect the work function, and (ii) the oxygen exposure did not produce significant irreversible changes in the filament surface. (auth)

**46286** ADSORPTION STUDIES BASED ON THERMIONIC EMISSION MEASUREMENTS. III. OXYGEN ON POLYCRYSTALLINE W, Mo, Ta, AND Re. Greaves, W.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). Surface Sci., 11: 395-410(Aug. 1968).

Thermionic measurements are reported for the adsorption and desorption of oxygen on polycrystalline filaments of W, Mo, and Re. The data illustrate the dependence of the effective work function on oxygen pressure and filament temperature in the range $1 \times 10^{-9} - 5 \times 10^{-5}$ torr and 1800–2200°K. These data may be correlated quite well by means of the parameter $T/T_R^*$, where T is the filament temperature, and $T_R^*$ is the saturation temperature corresponding to the oxygen pressure. Oxygen desorption energies have been estimated from measurements of the rate of change of thermionic emission following a sudden change in filament temperature and/or oxygen pressure. The results are 6.05 ± 0.1 eV (139 kcal) for W, 5.75 ± 0.25 eV (132 kcal) for Mo, and 5.5 ± 0.15 eV (127 kcal) for Re. These values are compared with existing data on the desorption energies and heats of adsorption of oxygen on metallic surfaces. The interaction of oxygen with Ta differs markedly from the corresponding cases for W, Mo, and Re, and it is suspected that this is due to the diffusion of O into Ta. Since the thermionic emission did not attain a stable value until many minutes after a change in pressure or temperature, reliable data could not be obtained for Ta. (auth)

**46287** ADSORPTION STUDIES BASED ON THERMIONIC EMISSION MEASUREMENTS. I. CESIUM ON SINGLE-CRYSTAL TUNGSTEN. Coggins, J. L.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). Surface Sci., 11: 355-69(Aug. 1968).

Studies are made on the thermionic properties of metallic surfaces partially covered with adsorbed atoms. A simplified version of the cylindrical thermionic emission microscope (TEM) is used to measure the current emitted along the various crystallographic directions of a single-crystal tungsten filament, both in vacuum and in cesium. Since the filament axis is parallel to the (110) direction, the emission directions are restricted to the class (hhk). The measurements in vacuum are in good agreement with those obtained with more refined versions of the TEM [e.g., G. F. Smith]. Only the (110) and (112) directions are studied in cesium vapor because the emission currents of the other crystallographic directions are too small to be measured accurately in this experiment. The dependence of the thermionic emission in these two directions on filament temperature is determined for a cesium reservoir temperature of 40°C, and the results are compared with existing experimental data and theoretical predictions. (auth)

**46288** EFFECTS OF IMPURITIES ON HIGHER-ORDER PHASE TRANSITIONS. Cadieu, F. J.; Douglass, D. H. Jr. (Univ. of Chicago). Phys. Rev. Lett., 21: 680-2(Sept. 2, 1968).

Measurements of the linear thermal expansion coefficient α of Gd crystals have shown that $T_c$ as well as the temperature dependence of α is a function of the electron-impurity mean free path. These results have allowed us to infer the temperature dependence of the coherence length ξ. (auth)

**46289** SECOND LAYER MIGRATION WITH TRAPPING ON FIRST LAYER SITES: HYDROGEN, NITROGEN, AND CARBON MONOXIDE ON TUNGSTEN. Folman, Mordecai; Klein, Ralph (National Bureau of Standards, Washington, D. C.). Surface Sci., 11: 430-42(Aug. 1968).

Second layer migration of hydrogen, nitrogen, and carbon monoxide with trapping on first layer sites of tungsten is observed with a field emission microscope. The initial deposition on the tungsten surface at 4.2°K is made with molecular beams with the tungsten emitter axis perpendicular to the beam direction. The migration of the deposit is effected at temperatures far below those for which the chemisorbed layer is mobile. The shapes of the sharp line boundaries as the second layer migrates over the chemisorbed layer and onto the clean tungsten substrate are quite different for the three gases observed. It is proposed that, in addition to the barrier effects of certain planes of the tungsten, the density of trap sites on the clean surface determines the boundary configuration. (auth)

## Theoretical Physics

*Refer also to abstracts 45916, 46353, and 46851.*

**46290** (UCRL–50438) MAFCO II: A CODE FOR CALCULATING A GUIDING CENTER TRAJECTORY OF A PARTICLE IN MAGNETIC AND ELECTRIC FIELDS. Perkins, W. A.; Fuss, D. (California Univ., Livermore. Lawrence Radiation Lab.). May 28, 1968. 27p. Dep. CFSTI.

MAFCO II is written in FORTRAN language and can be used on any computer which can compile a machine language code from a FORTRAN deck and has a memory greater than 50,000 words. The purpose of the code is to allow one to follow the guiding-center trajectory of a particle in a magnetic field generated by rather general current elements. The magnetic field is calculated in the same manner as in MAFCO, with the addition that it can change with time. One can introduce electric fields which are constant over designated regions of space and others which are created by point charges. The current-carrying conductors must be approximated by straight lines, circular loops, arcs of circles, or series of points designating the geometry of a general current element. For the guiding center approximation to be valid, the particle motion must be adiabatic. (auth)

**46291** MATRIX METHODS IN QUANTUM MECHANICS. Merzbacher, Eugen (Univ. of Washington, Seattle). Amer. J. Phys., 36: 814-21(Sept. 1968).

Some standard results of matrix theory are derived in a manner designed to appeal to physicists and are illustrated by examples from quantum mechanics. Sylvester's formulas, expressing a function of any n-dimensional square matrix as a linear combination of the first n − 1 powers of A, are applied to the evaluation of the rotation matrices $D^{(j)}(R)$ for low values of j. The neutral K meson is used as an example of the usefulness of matrix techniques for systems with two basis states. (auth)

**46292** NON-RELATIVISTIC QUANTUM MECHANICS. An Introduction. Second Edition. Sillitto, R. M. New York, American Elsevier Publishing Company, Inc., 1968. 324p. $8.50.

Chapters included are entitled as follows: (1) general principles,

(2) the uncertainty principle and the commutation relations, (3) the matrix treatment of the simple harmonic oscillator, (4) quantization of angular momentum, (5) the radial function and the total energy, (6) the perturbation method and the variation method in quantum statistics, (7) many-electron atoms and the hydrogen molecule, (8) quantum statistics, (9) the motion of a particle in wave mechanics, (10) time-dependent perturbations, and (11) the quantization of radiation. (M.O.W.)

**46293** QUELQUES METHODES DE RESOLUTION DE PROBLEMES AUX LIMITES DE LA PHYSIQUE MATHEMATIQUE. (Methods of Resolution of Some Boundary Problems in Mathematical Physics). Lattes, Robert. Cours et Documents de Mathematiques et de Physique. Paris, London, and New York, Gordon and Breach, 1967. 194p. [Dunod Editeur, Paris].

A book designed for students or engineers presents the method of resolution of some boundary problems in mathematical physics. It is designed to give work tools to the specials by illustrating these tools in use on concrete examples. Spectral methods and Monte Carlo methods of resolution of boundary problems are considered. (J.S.R.)

**46294** ON THE THEORY OF TRANSPORT PHENOMENA IN MANY-COMPONENT FERMI-SYSTEMS. Anokhin, S. B.; Kondrat'ev, A. S. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 27-9(Feb. 1968). (In Russian).

The exact equations for the Green functions of the real time variables for the nonequilibrium many-component Fermi systems are derived. The generalized Boltzmann equations fit for the description of any type of transport phenomena are obtained. (auth)

**46295** ON THE PROBLEM OF THREE-PARTICLE SCATTERING WITH COULOMB INTERACTION. Veselova, A. M. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 148-9(Feb. 1968). (In Russian).

The scattering amplitude for the system of three particles with Coulomb interaction is shown to have no logarithmic singularities analogous to those in the case of two particles. (auth)

**46296** GENERAL PERTURBATION AND VARIATIONAL METHODS FOR RESPONSES TO TIME-DEPENDENT INTERACTIONS IN QUANTUM MECHANICS. Heinrichs, Jean (Univ. of California, San Diego, La Jolla. Univ., Liege). Phys. Rev., 172: 1315-24(Aug. 25, 1968).

The perturbed energy of a system in the presence of a generally time-dependent external perturbation, in the limit where all transient effects have disappeared, but still in a range where eventual real transitions can be neglected, contains a term which is proportional to the so-called "response function" giving the response to the external field. This term can be identified and separated quite generally from the total energy perturbation, and the perturbed wave function can be written in the form of a product of a time-dependent amplitude and a time-dependent phase factor involving only this part of the perturbed energy. Using this expression for the wave function, a time-dependent perturbation formalism is developed in which the response to a given perturbation is obtained from just that term of the energy identified above, rather than from the expectation value of the operator corresponding to the response to be determined. A well-known formal difficulty inherent in the Dirac method of variation of constants is avoided in this way. The present method enables a variational principle to be constructed by introducing a certain time-averaged energy functional, whose stationary value is precisely the average of the energy term which depends on the response function only. It can therefore be used for variational derivations of approximations for responses to dynamical perturbations. In the case of a static perturbation, the present perturbation-variation formalism is equivalent to the ordinary time-independent one. These new techniques are illustrated by a detailed discussion of the polarization of free atoms or molecules in an oscillating electric field. (auth)

**46297** QUANTUM MECHANICS, OBSERVATION, AND INTERPRETATION. Lande, Alfred (Ohio State Univ., Columbus). Int. J. Theor. Phys., 1: 51-60(May 1968). (In German).

The doctrine of wave-particle duality and complementarity has been regarded since the late 1920's as the only possible interpretation of observations such as electron diffraction through crystals and screens with two slits as well as other coherence phenomena. These apparent wave features can, however, be accounted for by the unitary quantum mechanics of matter particles alone if it is admitted that there are three (rather than only two) conservation laws of mechanics, and hence there are three (rather than two) corresponding selection rules, for E, $p_\varphi$ and also for the linear momentum p, restricting the mechanical activity of time-, angular-periodic, and also of space-periodic systems. This clears up the mystery of dualism in a physical manner, without philosophical subtleties and leads to a great simplification of the quantum ideology. (auth) (UK)

**46298** NUMERICAL RESOLUTION OF CERTAIN SYSTEMS OF INTEGRO-DIFFERENTIAL EQUATIONS IN QUANTUM MECHANICS. Feautrier, Nicole; Feautrier, Paul; Lan, Vo Ky (Observatoire de Paris-Meudon, France). Compt. Rend., Ser. A and B, 267: 1-3(July 1, 1968). (In French).

A method for the numerical resolution of systems of integro-differential equations of second order with boundary conditions is given. It is particularly suitable for scattering problems in quantum mechanics. (tr-auth)

**46299** GENERAL THEOREM FOR INTERACTING MANY-PARTICLE SYSTEMS. Misawa, Setsuo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 1426-31(June 1968).

It is shown that the kinetic energy of any interacting many-particle system in its ground state is a monotone increasing function with respect to the absolute value of the coupling constant (or the interaction strength). A concise derivation of the virial theorem for simple power law potentials is also presented with particular emphasis on the case of an electron gas in a uniform background of positive charge. (auth)

**46300** MEAN ENTROPY OF STATES IN QUANTUM-STATISTICAL MECHANICS. Lanford III, Oscar E. (Univ. of California, Berkeley); Robinson, Derek W. J. Math. Phys. (N. Y.), 9: 1120-5 (July 1968).

The equilibrium states for an infinite system of quantum mechanics may be represented by states over suitably chosen C* algebras. We consider the problem of associating an entropy with these states and finding its properties, such as positivity, subadditivity, etc. For the states of a quantum-spin system, a mean entropy is affine and upper semicontinuous. (auth)

**46301** MILNE PROBLEM IN RADIATIVE TRANSFER. Williams, M. M. R. (London Univ.). Mon. Notic. Roy. Astron. Soc., 140: 403-7(1968).

The problem concerning the equivalence of special models in neutron transport theory and nongrey radiative transfer, first considered by Stewart et al. (1966), is extended. It is shown that the solution of this problem for the uniform picket fence (U.P.F.) model obtained by Siewert & Zweifel (1966) can be deduced very simply from results already obtained in neutron transport theory. A simple expression for the Milne problem extrapolated endpoint is obtained for the U.P.F. model and the model is extended to include an arbitrary scattering term. The latter problem can also be solved by noting its similarity with a corresponding problem in neutron transport theory. (auth) (UK)

**46302** THEORY OF FINITE GROUPS: APPLICATIONS IN PHYSICS. SYMMETRY GROUPS OF QUANTUM MECHANICAL SYSTEMS. Jansen, Laurens; Boon, Michael. New York, John Wiley and Sons, Inc., 1967. 376p. $19.00.

The fundamental theory of finite groups and their matrix representations and corepresentations is developed as an entity independent of applications. The theory is then applied to the problem of finding the symmetry groups of quantum mechanical solid-state and molecular systems. A discussion of basic properties of the systems is followed by specific applications to spinless electrons in a crystal potential, to electrons with spin in a crystal potential with spin–orbit coupling, and to a treatment of the system of a Dirac electron in an external electromagnetic field. The concepts of time reversal and of Kramers' degeneracy are included. An appendix contains a complete derivation of the finite point groups and crystallographic point groups. (A.G.W.)

**46303** DEFINITION OF POSITION OPERATOR FOR RELATIVISTIC ELEMENTARY SYSTEMS. Fonds, L.; Ghirardi, G. C. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim., 56A: 1094-8(Aug. 21, 1968).

An attempt is made to show that the results of Newton and Wigner (Rev. Mod. Phys., 21: 400(1949)) can be obtained in a simple manner by following the usual procedure for the definition of the position operator in quantum mechanics. (L.B.S.)

**46304** PROBLEMS CONCERNING MEASUREMENT: A STUDY OF THE FOUNDATIONS OF QUANTUM THEORY. PARTS I-III. Park, James Lemuel. New Haven, Yale Univ., 1967. 249p.

Thesis.

Although the quantum era of natural philosophy dawned amid problems of interpretation, it is widely believed that conceptual difficulties associated with quantum physics were long ago resolved in Copenhagen. Thus modern physicists have concentrated primarily upon applications of the quantum algorithm and excluded from consideration deeper issues concerning its logical and epistemological structure. However, there has recently been a resurgence of interest in problems of this more philosophic kind; and the center of attention has been the concept of measurement. This dissertation explores problems of measurement in quantum theory largely from the vantage point of theoretical

physics, but due emphasis is also placed on the philosophic aspects of any such basic inquiry. The work is divided into three self-contained parts. (TSS) (Diss. Abstr.)

**46305** ON THE ESSENTIAL SPECTRUM OF THE MANY-PARTICLE SCHROEDINGER OPERATOR WITH COMBINED ZEEMAN AND STARK EFFECT. Arai, Masaharu (Nihon Univ., Tokyo). Publ. Res. Inst. Math. Sci., Ser. A, 3: 271-87(Mar. 1968).

The Schroedinger operator H for a system consisting of $N_0$ infinitely heavy nuclei and N electrons which is exposed to an external electromagnetic field is given. H is formally self-adjoint and determines a unique self-adjoint operator in Hilbert space. Zislin, Jörgens and others have investigated the spectrum of H when the external electric field does not exist. But no complete study has been made for the spectrum of H with the external electric field. Titchmarsh has considered the special case with $N_0 = N = 1$. The spectrum of H is studied for arbitrary $N_0$ and N. It is shown that the essential spectrum of H is the entire real axis. It is unknown whether H has a point spectrum or not. (J.H.R.)

**46306** STRUCTURE OF THE FERMION DENSITY MATRIX. Witten, Louis (RIAS, Baltimore). pp 189-203 of Statistical Mechanics: Foundations and Applications. Proceedings of the I.U.P.A.P. Meeting, Copenhagen, 1966. Bak, Thor A. (ed.). New York, W. A. Benjamin, Inc., 1967.

See CONF-660727.

One of the key problems involved in understanding the structure of the p'th-order density matrix has been called the ensemble N-representability problem. It is the problem of how to recognize whether a given p'th-order-reduced density matrix is derivable by integrating the density matrix formed from an ensemble of dynamically possible states of the system (antisymmetric wave functions for fermions) over all by p coordinates. This problem is equivalent to asking for the dynamically permitted structure of reduced density matrices; i.e., the allowed sets of eigenvalues and eigenfunctions. The possible structure of the one-particle-reduced density matrix is understood and described. The two-particle-reduced matrix is of much greater interest and of correspondingly greater complexity. The possible structure of this matrix is partially understood and a description is presented which permits many families of allowed two-particle-reduced matrices to be specified. (auth)

# PHYSICS (HIGH ENERGY)

## Particle Interactions and Properties (Experimental)

**46307** (AED-C-23-21-1) HIGH ENERGY PHYSICS INDEX. VOLUME 5, AUTHOR INDEX, REPORT NUMBER INDEX. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 732p. Dep.

**46308** (AED-C-23-21-2) HIGH ENERGY PHYSICS INDEX. VOLUME 5, SUBJECT INDEX. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 866p. Dep.

**46309** SEARCH FOR HEAVY TRIPLETS IN COSMIC RAYS. Kasha, Henry (Brookhaven National Lab., Upton, N. Y.); Stefanski, Raymond J. Phys. Rev., 172: 1297-1303(Aug. 25, 1968).

A search for heavy stable particles in cosmic rays has been concluded. While the experiment was particularly designed to detect heavy triplets which might form the bases of the $SU_3$ symmetries observed in elementary particles, the results also concern particles of other possible origins. Particle detection was accomplished by means of a mass spectrograph which incorporated fast time-of-flight techniques and momentum analysis for the measurement of particle mass. The spectrograph had an aperture of $10^{-2}$ $m^2$ sr, a time-of-flight resolution of 2.5 nsec, and a maximum detectable momentum greater than 300 GeV/c. Measurements were made at an angle of 75° with respect to the zenith. Four possible heavy particles were found in 700 h of running, where estimates indicate that five background events were to be expected for the run. The results set an upper limit of $2.4 \times 10^{-9}$ $(cm^2\ sr\ sec)^{-1}$ to the flux of particles with a velocity between 0.5c and 0.75c. Calculations based on plausible assumptions for triplet production in nucleon-nucleon interactions and based on the results of this experiment give an upper limit of about 2 $\mu b$ for the production cross section of triplets of mass less than 15 $GeV/c^2$. (auth)

### *Electromagnetic*

**46310** (JINR-P1-3976) INVESTIGATION OF THE ELECTRON-PHOTON SHOWERS WITH THE SCINTILLATION COUNTERS. Zaimidoroga, O. A.; Kut'in, V. M.; Prokoshkin, Yu. D.; Tsupko-Sitnikov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 14p. (In Russian). Dep.

Cascade curves, fluctuations of the secondary electron number and the angular divergence of the showers, produced in lead by 115- and 217-MeV electrons, were measured. The characteristics are determined on the basis of an analysis of the amplitude distributions of the scintillation counter pulses, which is used to measure the number of particles in the shower. The measurements were carried out at different values of cutoff energy of the secondary electron spectrum. (auth)

**46311** (NYO-2262-TA-193) PION-ELECTRON SCATTERING. Internal Report No. 113. Kang, K.; Widgoff, M. (Brown Univ., Providence, R. I. Dept. of Physics). July 1968. Contract AT(30-1)-2262. 16p. (NYO-2262-TB-138). Dep. CFSTI.

A study was made of the possibility of measuring the cross section for $\pi$-e scattering as a function of the final electron energy, and of obtaining from these data a measure of the electromagnetic radius of the pion. From the existing information on $\langle r_\pi^2 \rangle^{1/2}$, it appears that the cross section will be only slightly different from that of a point charge. Thus, very high statistics and/or a very high incident pion momentum will be needed to establish a difference. However the previous data are limited and the problem is of great interest, so it seems worthwhile to pursue this study. (auth)

**46312** A MEASUREMENT OF THE MAGNETIC MOMENT OF THE $\Sigma^+$-HYPERON. Combe, J. (CERN, Geneva); Dahl-Jensen, E.; Doble, N.; (and others). Nuovo Cim., 57A: 54-68 (Sept. 1, 1968).

The magnetic moment of the $\Sigma^+$-hyperon was measured to be $(3.5 \pm 1.2)$ nuclear magnetons by observing the precession of the polarization vector in a pulsed magnetic field. The polarized hyperons were produced in a liquid-hydrogen target by a beam of 1.17 GeV/c $\pi^+$-mesons and their decay was detected in pellicles of nuclear emulsion. The final direction of the polarization was determined from the angular distribution of the decay $\Sigma^+ \rightarrow p\pi^0$. (auth)

**46313** POSITIVE PION PHOTOPRODUCTION FROM HYDROGEN FOR INCIDENT PHOTON ENERGIES 300 TO 750 MeV. Betourne, C. (Ecole Normale Superieure, Orsay, France); Bizot, J. C.; Perez-Y-Jorba, J.; Treille, D.; Schmidt, W. Phys. Rev., 172: 1343-54(Aug. 25, 1968).

The differential cross section for the reaction $\gamma + p \rightarrow \pi^+ n$ was measured at 19 photon energies between 300 and 750 MeV in the laboratory frame, for pion angles between 0° and 130° in the c.m. system. The pions were analyzed in angle and momentum with a magnetic spectrometer and detected by a counter telescope. The 0° measurements could be achieved, in spite of the excessive positron rate, owing to a mass-spectrometer arrangement. No direct indication for the electromagnetic excitation of the $P_{11}$ resonance (1466 MeV) was found. Comparison is made with theoretical calculations of $\pi^+$ photoproduction. (auth)

**46314** POSITON-NEGATON SCATTERING. Connor, F. R. (University Coll., London). Nucl. Phys., B6: 693-700(1968).

The scattering of positons by negatons in the energy range 1.52 MeV to 2.62 MeV was investigated experimentally. A beta-ray spectrometer was employed and a coincident counting technique was used to detect the scattered particles. The results obtained verify the Bhabha formula for positon-negaton scattering which is the generally accepted theory. (auth)

**46315** $\pi^-$-PHOTOPRODUCTION FROM HYDROGEN AT 60° BETWEEN 0.85 AND 1.21 GeV. Burq, J.-P.; Chollet, J.; Fourneron, Th.; Lehmann, P. (Ecole Normale Superieure, Orsay, France). Nuovo Cim., 56A: 1142-6(Aug. 21, 1968).

A search was made for an effect of the 1688 resonance in the $\gamma + p \rightarrow \pi^- + \pi^+ + p$ reaction by measuring the differential cross sections at 0.85 to 1.21 GeV with a higher accuracy than previous measurements, at fixed $\pi^-$ laboratory angle $\theta$. Results are reported for $\theta = 60°$. No significant evidence for such an effect was found. (L.B.S.)

**46316** DOUBLE PION PHOTOPRODUCTION ON PROTONS BELOW 1 GeV. AN INVESTIGATION OF THE ISOBAR EXCITATION MECHANISM. Fiore, L. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Gialanella, G.; Rossi, V.; De Schryver, S.; Piazza, A.; Stella, B.; Susinno, G.; Focardi, S.; Mantovani, G. C. Nuovo Cim., 56A: 1099-1105(Aug. 21, 1968).

The preliminary results are reported of an investigation of the double photoproduction reaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$ at 450 to 1000 MeV using a hydrogen bubble chamber. The main characteristic of the reaction is the abundant production of the $\Delta^{3+}(1236)$ isobar. Results are given of the fit of the $p\pi^+$ mass distribution obtained by superimposing a Breit-Wigner distribution for the $\Delta$-isobar to the phase-space distribution. The data are analyzed using the resonant model, essentially as regards the decay angular distributions of the $\Delta$-isobar at various photon energies. (L.B.S.)

### *Weak*

**46317** (COO-1195-129) AN UPPER LIMIT ON THE DECAY RATE $K_L^0 \rightarrow \pi^+\pi^-\gamma$. Thatcher, R. C.; Abashian, A.; Abrams, R. J.; Carpenter, D. W.; Mischke, R. E.; Nefkens, B. M. K.; Smith, J. H.; Verhey, L. J.; Wattenberg, A. (Illinois Univ., Urbana). [1968]. 19p. (CONF-680809-24). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

A search was made for the decay mode $K_L^0 \rightarrow \pi^+\pi^-\gamma$. The charged decay products were momentum analyzed in a magnet and identified in a set of range-shower spark chambers. The position of the gamma ray conversion point in these chambers was compared with the position predicted on the hypothesis of $K_L^0 \rightarrow \pi^+\pi^-\gamma$. The $K_{\pi 3}$ provided almost the sole background as well as the normalization of the rate measurement. In 962 events with good gamma showers, one event fitted the $\pi\pi\gamma$ hypothesis within the spacial resolution. However, the expected background was one event. This result corresponds to an upper limit on the decay rate $R(K^0 \rightarrow \pi^+\pi^-\gamma) \leq 7.5 \times 10^3\ sec^{-1}$ at a confidence level of 90%. (auth)

**46318** (UCI-10-P-19-4) SEARCH FOR THE DISINTEGRATION OF DEUTERONS BY ELECTRON ANTINEUTRINOS. Munsee, Jack Howard (Case-Western Reserve Univ., Cleveland, Ohio). Sept. 1968. 81p. Dep. CFSTI.

Thesis.

An attempt was made to measure the cross section for the disintegration of the deuteron by electron antineutrinos ($\bar{\nu}_e$) in order to comment on the validity of the neutral weak interaction current theory. This event could be recognized by the detection

of both disintegration products, the neutron and the proton. The proton would be detected in a deuterated liquid scintillator which also serves as the target. The liquid scintillator was loaded with gadolinium whose neutron capture gammas were detected by two cylindrical NAI(Tl) crystals located on opposite sides of the liquid scintillator. The signature for the event would be a prompt "proton" pulse followed by a coincidence between the two crystals which signaled neutron capture. The crystal energy gates were set between 0.75 and 6.25 MeV and the liquid scintillator gates were set to see the light output equal to that produced by electrons of energies greater than 0.20 MeV and less than 0.59 MeV. During approximately 56 hours of running time near one of the Savannah River Plant reactors, an upper limit on the cross section for this process was determined to be $1.7 \pm 1.7 \times 10^{-42}$ cm$^2$, a number which is to be compared with a maximum "theoretical" expectation of $1.3 \times 10^{-44}$ cm$^2$ and a previous experimental limit of $10^{-40}$ cm$^2$. (auth)

**46319** A MEASUREMENT OF THE RATIOS OF THE RATES $K_L^0 \to 3\pi^0/K_L^0 \to \pi^+\pi^-\pi^0$, $K_L^0 \to 3\pi^0/K_L^0 \to$ ALL CHARGED MODES AND $K_L^0 \to \pi\mu\nu/K_L^0 \to \pi e\nu$, AND TESTS OF THE $\Delta I = 1/2$ RULE. Budagov, I. A. (CERN, Geneva); Burmeister, H.; Cundy, D. C.; (and others). Nuovo Cim., 57A: 182-9(Sept. 1, 1968).

Direct measurements were made of ratios of $K_L^0$ decay modes in a heavy-liquid bubble chamber exposure to a neutral beam. Three separate analyses were carried out using different scanning, selection and analysis procedures. The results are compared, combined and discussed. (L.B.S.)

**46320** INTERFERENCE BETWEEN NEUTRAL KAONS AND THEIR MASS DIFFERENCE. Mehlhop, W. A. W.; Murty, S. S.; Bowles, P.; Burnett, T. H.; Good, R. H.; Holland, C. H.; Piccioni, O.; Swanson, R. A. (Univ. of California, San Diego, La Jolla). Phys. Rev., 172: 1613-25(Aug. 25, 1968).

A $K^+$ beam of 990-MeV/c momentum was used to produce a $K^0$ beam in charge-exchange collision with a copper target. By interposing an iron regenerator at a certain distance from the target and taking spark-chamber pictures of $2\pi$ decays behind the regenerator, interference was observed in the $2\pi$ decay mode between the $K_S$ state produced in the original charge exchange and the $K_S$ state ($K_{1S}$) produced via regeneration. The difference in phase between these $K_S$ and $K_{1S}$ states depends upon the proper time elapsed between production and regeneration (because of the mass difference between $K_S$ and $K_L$) and can therefore be changed at will by changing the corresponding distance. The shape of the curve with the observed minimum gives the magnitude of the mass difference, and its sign as well if the phase of the regeneration amplitude is given for a separate work that phase was determined from scattering experiments with charged kaons on iron nuclei. Comparison that information with the present experiment, the following results are obtained: (1) The two-pion states into which $K_S$ and $K_{1S}$ decay are quantum-mechanically identical. Since $|K_1\rangle$ and $|K_{1S}\rangle$ interference has already been observed, it is then expected that the time dependence of the $2\pi$ decay of $K^0$ will differ from that of $\bar{K}^0$ because of the $|K_S\rangle \to |2\pi\rangle$, $|K_L\rangle \to |2\pi\rangle$ interference. (2) The sign of the mass difference is such that $K_L$ is heavier than $K_S$ with a level of confidence that, barring unknown systematic errors, appears to be beyond question. (3) The value of the mass difference obtained is $0.42 \pm 0.04$ in units of $\hbar/\tau_S$, where $\tau_S$ is the $K_S$ mean life. (4) The effect of the constructive interference between the scattered amplitude $f_{11}|K_S\rangle$ and the diffraction-regenerated amplitude $f_{21}|K_S\rangle$ was also observed. This effect confirms that $K_L$ is heavier than $K_S$. (auth)

**46321** FORM-FACTOR ANALYSIS FROM A TOTAL POLARIZATION MEASUREMENT IN $K^+\mu_3$ DECAY. Bettels, J. (Technische Hochschule, Aachen); Freudenreich, K.; Haidt, D.; (and others). Nuovo Cim., 56A: 1106-12(Aug. 21, 1968).

A total of 750,000 pictures were scanned for $K^+$ decays of the type $K^+ \to \mu^+ + \pi^0 + \nu$ from kaons stopped in the CERN heavy-liquid bubble chamber. The angular distribution of the muon decay positron was measured to determine the muon polarization and the ratio of two form factors $f_-/f_+$ as a function of the four-momentum transfer squared. Details are given of the polarization analysis and the determination of the form factor ratio. (L.B.S.)

## *Strong (Baryon-Induced)*

**46322** (JINR-E1-4022) SEARCH FOR RESONANCES IN $\Lambda_p$ SYSTEM IN COLLISIONS OF NEUTRONS WITH CARBON NUCLEI AT AN AVERAGE MOMENTUM OF 7 TO 8 GeV/c. Shakhbazyan, B. A.; Moroz, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1968. 14p. Dep.

The strong peak found in the $\Lambda_p$ system effective mass spectrum in the mass interval of 2053 to 2093 MeV is proved to be due to the strong interaction of Λ-hyperons with protons in final state. (auth)

**46323** (JINR-P1-3909) INELASTIC np-INTERACTIONS AT 2.10 GeV. I. NEUTRON INTERACTION, NEUTRON SPECTRA AND CROSS SECTIONS OF DIFFERENT REACTIONS. Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 14p. (In Russian). Dep.

The methods of determining the neutron spectra, which are emitted at $0^0$ to the proton trajectories in the synchrophasotron, were described. The cross sections of different channels of np-interactions were determined. (auth)

**46324** (UCRL-17707) ZERO STRANGENESS RESONANCE PRODUCTION IN 6 GeV/c PROTON-PROTON COLLISIONS. Kinsey, Robert Ronald (California Univ., Berkeley. Lawrence Radiation Lab.). June 1968. Contract W-7405-eng-48. 132p. Dep. CFSTI.

Thesis.

Approximately 33,000 four-pronged proton-proton interactions at 6 GeV/c were examined for the production of nonstrange meson and baryon resonances. These events were found by scanning approximately 112,000 pictures taken in the LRL 72-in. hydrogen bubble chamber. The reactions studied in detail and their cross sections are (1) $pp \to pp\pi^+\pi^-$ $3.2 \pm 0.3$ mb, (2) $pp \to pn\pi^+\pi^+\pi^-$ $2.9 \pm 0.4$ mb, and (3) $pp \to pp\pi^+\pi^-\pi^0$ $2.4 \pm 0.2$ mb. Proton-proton interactions were studied by others in this energy region and this experiment agrees with these studies in the general features of reaction (1). Reaction (1) is dominated by the pseudo-two-body final states NN* and N*N* produced in a peripheral manner. Fits to the various possible final states were made and are reported. Data from this reaction were also compared to the peripheral one-pion exchange (OPE) model and the results are given. In reactions (2) and (3), an interesting feature is the production of an $I = 3/2$ baryon resonance which is observed to decay into a nucleon and three pions and which produces a peak in the appropriate mass spectrum at 2080 MeV/c$^2$. In addition, the $\rho$ meson was detected for the first time in a bubble chamber proton-proton production experiment in addition to the $\eta$ and $\omega$ mesons already reported. Due to the complicated nature of the final states in reactions (2) and (3) fits to the numerous possible final states are not attempted. However an attempt was made to determine the production cross sections for various new or interesting resonances. (auth)

**46325** NEW METHOD OF HIGH ENERGY JET SHOWER ANALYSIS. RELATIVE FOUR-MOMENTUM BETWEEN SECONDARY PARTICLES. Hasegawa, Shun-ichi (Waseda Univ., Tokyo); Kasahara, Katsuaki; Shibata, Toru. Progr. Theor. Phys. (Kyoto), 39: 1487-1500(June 1968).

A new method of the analysis of high energy jets is developed. This method is related to the study of the correlation of secondary shower tracks observed in the target diagram which introduces the Lorentz invariant quantity; the spectrum of "relative four-momentum between two particles." The experimental data on high energy jets in emulsion stacks and emulsion chambers (ECC) are analysed by using this method. Comparing the experimental results with the Monte Carlo calculations on the basis of the fire ball model, one can identify fire balls which could not be observed by the knowledge of log tan $\theta$ plot only. It is shown that results of a detailed analysis are quite consistent with the H-quantum hypothesis which insists on the existence of energy (or mass) quantum in the violent collision of high energies.

**46326** EXPERIMENTAL RESULTS ON PROTON-PROTON INTERACTIONS AT 10 GeV/c WITH SIX CHARGED PARTICLES IN THE FINAL STATE. Holmgren, S. O.; Nilsson, S.; Olhede, T.; Yamdagni, N. (Univ. of Stockholm). Nuovo Cim., 57A: 20-38(Sept. 1, 1968).

High-multiplicity proton-proton reactions at 10 GeV/c were studied. In the analysis of 1937 events the following results were obtained: reaction 1) $pp \to pp\pi^+\pi^+\pi^-\pi^-$, $\sigma = (0.46 \pm 0.04)$ mb, 2) $pp \to pp\pi^+\pi^+\pi^-\pi^-\pi^0$, $\sigma = (0.69 \pm 0.05)$ mb, 3) $pp \to pn\pi^+\pi^+\pi^+\pi^-\pi^-$, $\sigma = (0.54 \pm 0.04)$ mb, 4) $pp \to$ >1 neutral particle, $\sigma = (0.76 \pm 0.05)$ mb. The fraction of $\Delta^{++} \to p\pi^+$ is $0.64 \pm 0.16$ in channel 1), $0.60 \pm 0.12$ in 2) and $0.48 \pm 0.09$ in 3). There is evidence for production of $\Delta^{++}(1920) \to p\pi^+$ in reaction 3) and $\Delta^+(1920) \to p\pi^0$ in reaction 2). No significant evidence for other baryon resonances, meson resonances or double isobar production was found. (auth)

**46327** STRANGE-PARTICLE PRODUCTION IN 8-BeV/c PROTON-PROTON INTERACTIONS. Firebaugh, M.; Ascoli, G.; Goldwasser, E. L.; Sard, R. D.; Wray, J. (Univ. of Illinois, Urbana). Contract AT(11-1)-1195. Phys. Rev., 172: 1354-69 (Aug. 25, 1968). (COO-1195-109).

A systematic survey of strange-particle final states produced by 8-BeV/c protons was made in the BNL 80-in. hydrogen bubble chamber. Cross sections were measured for some 33 reactions.

The ratio of the cross section for the $K\bar{K}$ channels to the total strange-particle cross section was measured to be 0.12 and appears to be rising in this momentum region. The total cross section for strange-particle production is estimated as 1.8 ± 0.2 mb. Comparison is made of the data with the predictions of the one-pion-exchange model, and at least partial agreement occurs for the $K^+p\Lambda$ and $\pi K N\Sigma$ final states. The $Kp\Sigma$ states appear to contain $N^*(1924) \rightarrow K\Sigma$, and the $\pi KN\Lambda$ states all include $Y^*(1385)$ production with the $\pi^+K^0p\Lambda$ state also containing $N^*(1236)$ and $K^*(890)$ production. An examination of the five- and six-body $K,\Lambda$ states indicates strong $Y^*(1385)$ and $N^*(1236)$ production. Finally, all final states containing a K and a Λ show a dependence on M(K,Λ) which is well parametrized by a Breit–Wigner shape with $M_0$ = 1777 MeV and Γ = 345 MeV. This behavior is interpreted as being consistent with one-pion exchange as the dominant mechanism for these reactions. (auth)

**46328** DOUBLE-REGGE-POLE MODEL ANALYSIS OF $pp \rightarrow pn\pi^+$ AT 28.5 GeV/c: PION EXCHANGE AND THE 1400-MeV πN ENHANCEMENT. Berger, Edmond L. (Dartmouth Coll., Hanover, N. H. Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 701-4(Sept. 2, 1968).

Experimental distributions in all kinematic variables for the reaction $pp \rightarrow pn\pi^+$ at 28.5 GeV/c are consistent with predictions of a double-Regge-pole model employing Pomeranchuk and pion exchanges with the pion required to couple in conspiracy fashion to np. The 1400-MeV πN enhancement seen in these data is well fitted. (auth)

**46329** SINGLE–ISOBAR PRODUCTION IN PROTON–PROTON INTERACTIONS AT 28.5 GeV/c. Ellis, W. E.; Miller, D. J.; Morris, T. W.; Panvini, R. S.; Thorndike, A. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 697-700 (Sept. 2, 1968).

Two- and four-prong final states in a 28.5-GeV/c p-p bubble-chamber experiment were examined for single-isobar production in various decay channels; results are compared with missing-mass-spectrometer data. The 1400 enhancement was found to be an Nπ system with the ratio $n\pi^+/p\pi^0 \sim 2$, which establishes the isospin assignment I = ½. The final state $\Delta^{++}(1238)n$ was measured and compared with low-energy data to show that the cross section decreases according to $P_{lab}^{-(1.91\pm0.08)}$, consistent with single-pion exchange. (auth)

**46330** ELASTIC SCATTERING OF ANTIPROTONS ON POLARIZED PROTONS AT 1.73, 2.13, 2.37, AND 2.97 GeV/c. Daum, C.; Erne, F. C.; Lagnaux, J. P.; Sens, J. C.; Steuer, M.; Udo, F. (CERN, Geneva). Nucl. Phys., B6: 617-27(1968).

Differential cross section and polarization distributions are presented for elastic $\bar{p}p$ scattering at incident momenta of 1.73, 2.13, 2.37, and 2.97 GeV/c. The data have been analyzed in terms of a 5-parameter diffraction model. In terms of this model the difference in the shape of the differential cross sections for $\bar{p}p$ and pp elastic scattering is a result of the strong absorption in the $\bar{p}p$ system. (auth)

**46331** MULTIPLE COULOMB SCATTERING OF HIGH-ENERGY PARTICLES IN NUCLEAR EMULSIONS. Wong, E.; Jain, P. L. (State Univ. of New York, Buffalo). Nuovo Cim., 56A: 922-34(Aug. 21, 1968).

Ilford G-5 emulsions were exposed to four primary proton beams of momentum 5, 8, 12 and 24 GeV/c at different angles in the same emulsion for the study of the scattering constant at higher cell sizes. The effect of higher-order differences was considered along with the relative scattering method to remove spurious scattering. The results appear to indicate the necessity for a slight modification in the theory of multiple Coulomb scatterings at large cell lengths. (auth)

**46332** ANNIHILATION OF 3-GeV/c ANTIPROTONS BY NUCLEONS OF IONOGRAPHIC EMULSION. Montret, Jean-Claude (Faculte des Sciences, Clermont, France). J. Phys. (Paris), 29: 419-26(May-June 1968). (In French).

A study of the "white-stars" induced in (G5) nuclear emulsion by the annihilation of 3 GeV/c antiprotons provides information about the average number, momentum spectrum and angular distribution of the pions emitted. Some information on kaon emission and interaction volume is obtained. (auth)

## *Strong (Meson-Induced)*

**46333** (BNL–12739) STUDY OF COHERENT $K^-$ INTERACTIONS ON NUCLEI AT 5.5 AND 12.7 GeV/c. Bingham, H. H.; Farwell, C. W.; Fretter, W. B.; (and others) (Brookhaven National Lab., Upton, N. Y.). [1968]. 17p. (CONF-680809–15). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

The observation and preliminary analysis of $K^-\pi^+\pi^-$ final states produced coherently on neon nuclei by $K^-$ mesons of 5.5 and 12.7 GeV/c are reported. Approximately 1000 events at 5.5 GeV/c and 3000 at 12.7 GeV/c were obtained from two exposures in the hydrogen–neon bubble chamber and fitted to the 1c reaction $K^- + n \rightarrow K^- + \pi^+ + \pi^- + n$. There is evidence for $K^*(890)$ and ρ production. The $K\pi\pi$ mass spectra at 5.5 and 12.7 GeV/c for $K^-\pi^+$ masses in the $K^*$ band show evidence of peaking at 1.26 GeV with a width of 300 MeV, in the region of the Q enhancement. (J.F.P.)

**46334** (COO-1195-133) OBSERVATION OF THE $A_2^-$ MESON IN 5 GeV/c $\pi^-p$. Ascoli, G.; Bridges, C. A.; Crawley, H. B.; Eisenstein, B. I.; Hanft, R. W.; Kruse, U. E.; Mortara, D. W.; Schafer, E. D.; Shapiro, A.; Terreault, B. (Illinois Univ., Urbana). [1968]. 15p. (CONF-680809-20). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

In a 150,000 picture (~6 events per microbarn) exposure in the 72″ hydrogen bubble chamber at Berkeley the $A_2$ meson was studied in 4-prong events. In particular the reaction $\pi^-p \rightarrow A_2^-p$ with subsequent decay into $\rho^0\pi^-$, $\eta^0\pi^-$, and $x^0\pi^-$ was observed. Results on the branching ratios and on the decay angular distributions for $A_2 \rightarrow \eta^0\pi^-$ have been reported previously. In the previous work the $A_2$ was treated as a single resonance using the mass interval 1.20–1.40 GeV. The results obtained on the CERN mass spectrometer indicate that the $A_2$ may consist of two separate resonances or may be a double pole. In view of this possibility the $A_2$ data are presented with particular emphasis on the split vs. single $A_2$ question and also on the possible spin-parity assignments for the lower and upper $A_2$ if the $A_2$ is split. (auth)

**46335** (JINR-P1-3946) DOUBLE CHARGE EXCHANGE OF $\pi^-$-MESONS AT THE LOW ENERGY. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 5p. (In Russian). Dep.

The double charge exchange of $\pi^-$-mesons on nuclei in the photoemulsion was detected at an energy at 15 MeV. The total cross section is $(4.6 \pm 3.4)\ 10^{-29}$ cm$^2$ at this energy. The process of the double charge exchange for slow $\pi^-$-mesons in the capture by $^{58}$Ni nuclei was investigated. The relative probability of this reaction compared to the total probability for $\pi^-$-mesons capture in $^{58}$Ni is found to be smaller than $3.10^{-6}$. (auth)

**46336** (UCR-34-P-107-72) REACTION $\pi^+ + p \rightarrow \Delta^{++}(1236) + \pi^0$ BETWEEN 1850 AND 2010 MeV CENTER-OF-MASS ENERGY. Fung, Sun-Yiu; Kernan, Anne (California Univ., Riverside); Kalmus, George E.; Birge, Robert W. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract AT(11-1)-34. 12p. (CONF-680809-17). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Cross sections and angular distributions for the reaction $\pi^+ + p \rightarrow \Delta^{++}(1236) + \pi^0$ at incident pion momenta 1.34, 1.42, and 1.68 GeV/c are given. From a study of the angular distributions the cross section for the partial wave amplitude F37 in this channel is estimated at 2.8 ± 0.6 mb and $4.5^{+1.0}_{-0.8}$ mb at 1.34 and 1.42 GeV/c respectively. These cross sections give a value 0.20 ± 0.04 for $x_{\pi N}x_{\Delta\pi}$ for the F37 resonance Δ(1950). (auth)

**46337** (UR-875-249) SEARCH FOR MULTIPION RESONANCES WITH I-SPIN = 2. Katz, W.; Ferbel, T.; Slattery, P.; Yamanouchi, T.; Yuta, H. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). July 30, 1968. Contract AT(30-1)-875. 15p. (CONF-680809-12). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

An 84,000 picture exposure of the 80-inch deuterium bubble chamber to 7-GeV/c negative pions was scanned for the reactions $\pi^- + d \rightarrow 2p + \pi^+ + 3\pi^-$ and $\pi^- + d \rightarrow 2p + \pi^+ + 3\pi^- + \pi^0$. A search was made for I = 2 mesons in the $4\pi$ and $5\pi$ states which were predicted to exist on the basis of symmetry. The results indicate that if these mesons exist and have widths below 160 MeV then they are produced in association with protons only with a cross section below 3 μb. (J.F.P.)

**46338** (UR–875-250) SEARCH FOR NEW MESON RESONANCES IN $K^+p$ INTERACTIONS AT 12.7 GeV/c. Berlinghieri, J. C.; Farber, M. S.; Ferbel, T.; Forman, B. E.; Melissinos, A. C.; Slattery, P. F.; Yamanouchi, T.; Yuta, H. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). July 30, 1968. Contract AT(30-1)-875. 13p. (CONF-680809–21). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austriaia.

In a study of $K^+p$ interactions at 12.7 GeV/c a search was made for meson resonances having any one of the following properties: (a) a strangeness of S = 2, (b) S = 1 and isotopic spin of I = 3/2, or

(c) S = 1, I = ½ and decaying into an antihyperon ($\bar{Y}$) and a nucleon (N). Resonances having properties (a) and (b) would belong to the larger, and as yet unobserved, multiplets of SU(3). The results of this experiment indicate that if these mesons exist and have masses <4 GeV then they are produced only with cross sections <5 μb. (auth)

**46339** LAMBDA-PROTON INTERACTIONS. Gibbs, Walter Leonard. Ann Arbor, Mich., Univ. of Michigan, 1967. 106p. Thesis.

A study was made of the lambda–proton interaction having a center of mass energy ranging between 2050 MeV and 3500 MeV, with particular attention being paid to the possibility of resonance phenomena. The experiment is part of a study of the interactions of 3.65 BeV/c $\pi^+$ mesons in a deuterium filled bubble chamber. The lambdas were created in reactions of the type $\pi^+ d \rightarrow p \Lambda (K\pi)^+$, where $(K\pi)^+$ is a combination of pions and kaons which have net positive charge, isospin ½ or 3/2, and strangeness +1. Departures in the behavior of protons and lambdas from the behavior predicted by assuming no interaction are carefully examined. The behavior of the proton is examined in light of the "spectator model," based on the "impulse approximation" and the Hulthén theory of the deuteron. The behavior of the lambda is examined in light of properties of the reaction $\pi^- p \rightarrow \Lambda(K\pi)^0$, where $(K\pi)^0$ is a combination of pions and kaons having strangeness +1, isospin ½ or 3/2, and zero net charge. This reaction is charge symmetric to the reaction $\pi^+ N \rightarrow \Lambda(K\pi)^+$ and, assuming charge symmetry, the cross sections are equal. The Λ-P effective mass spectrum is especially interesting. Although this spectrum, when contrasted to a background of non-interacting events, reveals none of the previously announced resonances, there is a significant accumulation of events above background in the range 2100–2200 MeV. This enhancement, whose center is at 2125 MeV, and whose width at half maximum is 40 MeV is discussed in terms of Λ-P elastic scattering and phenomena associated with the Σ-N threshold at 2130 MeV. (auth) (Disser. Abstr.)

**46340** MASS COMPOSITION OF PRIMARY COSMIC RAYS AT ENERGIES ABOVE $10^8$ GeV. Orford, K. J.; Turver, K. E. (Durham Univ., Eng.). Nature (London), 219: 706-8(Aug. 17, 1968).

Measurement of high momentum muons far from the core of a cosmic ray shower is stated to be a basis for estimating the mass of the primary particle. (auth)

**46341** ANALYSIS OF THE DECAY OF $\rho^-$ MESONS PRODUCED IN $\pi^- p$ INTERACTIONS AT 2.26 GeV/c. Reynolds, B. G.; Albright, J. R.; Bradley, R. H.; Brucker, E. B.; Harrison, W. C.; Harms, B. C.; Lannutti, J. E.; Sims, W. H.; Wieckowicz, R. P. (Florida State Univ., Tallahassee). Nucl. Phys., B6: 633-8(1968).

The spin density matrix elements for the decay of $\rho^-$ mesons produced at 2.26 GeV/c were determined. It is concluded that the data cannot be completely explained by the one-pion exchange model modified for absorption. (auth)

**46342** STUDY OF DIFFERENTIAL CROSS SECTION FOR THE REACTION $\pi^- p$ AT 11.5 GeV/c. Cotteron, J.; Fayolle, J. C.; Jacob, M. C.; de Montaignac, B.; Morand, M. (Univ., Paris). J. Phys. (Paris), 29: 391-4(May–June 1968). (In French).

The dependence of the differential cross section for inelastic processes $d\sigma/dt$ on the momentum transfer t was studied in the reaction $\pi^- p \rightarrow p + MM^-$, where MM stands for all masses, at incident momentum of 11.5 GeV/c and momentum transfer $0.18 < |t| < 0.37$ $(GeV/c)^2$. Data are fitted with an exponential $d\sigma/dt = K \exp(-|a|t)$. It was found that $a = 7.2 \pm 0.6$ for all masses in the band $1.5 < MM < 2.3$ GeV. There is a slow decrease of "a" with "MM": $a = (13.7 \pm 1.5) - (2.8 \pm 0.8)$ MM for 200 MeV wide mass bands and $a = (13.5 \pm 2.4) - (2.6 \pm 1.2)$ MM for 100 MeV wide mass bands. The computation of the number of decay particles shows a small decrease of "a", which is better seen when MM > 1.9 GeV. (auth)

# Particle Interactions and Properties (Theoretical)

## General

*Refer also to abstract 46494.*

**46343** (AED-C-23-27) HIGH ENERGY PHYSICS INDEX. VOLUME 6, No. 6 (2849-3600). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 268p. Dep.

The high energy physics index presented is divided into categories of experimental physics, including general, weak, electromagnetic and strong interactions, strange particles, accelerators, and methods and instruments; and theoretical physics including general, weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory. Author, report number, and subject indexes are included. (B.G.D.)

**46344** (JINR-E2-3986) UPPER LIMIT OF THE RADIUS OF THE ELEMENTARY PARTICLES AND THE LOWER BOUND OF THEIR FORMFACTORS. Baluni, V.; Nguyen Van Hieu; Suleimanov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 11p. Dep.

On the basis of the analyticity of the form factor the upper limit of the radius of the elementary particles is obtained. Also the lower bound for the form factor in the region $t < 0$ is established. (auth)

**46345** (JINR-E2-3990) ALGEBRA OF CURRENTS ON THE LIGHT CONE. Ersak, I.; Shtern, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 19p. Dep.

On the basis of the observation that the fixed-mass sum rules are Fourier transforms of the commutators of currents on a light-like hyperplane a new treatment of the algebra of currents is proposed. It consists in the use of the currents integrated over a light-like hyperplane ("light-like" charges) and thus includes the commutators of currents on the whole light cone. An algebra of the light-like charges is a sufficient assumption for the derivation of fixed-mass sum rules and may be represented in the one-particle space with any momenta. Hence this extension of the usual equal time current algebra allows one to abandon the methods like $p_z \rightarrow \infty$ without losing any of its advantages. (auth)

**46346** DEFINITE PARITY NUMBER FOR A FERMION. Mariwalla, K. H. (Inst. of Mathematical Sciences, Madras). Nuovo Cim., 57A: 154-7(Sept. 1, 1968).

An attempt is made to determine the extent to which a parity number can be assigned to fermions that is distinguishable from any other parity number, and to discuss its possible consequences. It is concluded that it is not meaningful to assign a definite parity number to fermions in general, because the relative parities of fermions can be compared only if they are the same or opposite and the precise number involved is representation-dependent and indeterminate in principle. (L.B.S.)

**46347** SPECTRAL-FUNCTION SUM RULE, VECTOR-MESON DOMINANCE AND THE CURRENT-MIXING MODEL. Majumdar, D. P. (State Univ. of New York, Stony Brook). Nuovo Cim., 57A: 170-3(Sept. 1, 1968).

An attempt is made to clarify the connection between the spectral-function sum rule, the vector-meson dominance hypothesis, and the $\omega-\varphi$ mixing models. It is emphasized that within the framework of the vector-meson dominance a particular model of the $\omega-\varphi$ system demands a particular form of the spectral-function sum rule. (L.B.S.)

**46348** CURRENT ALGEBRAS AND APPLICATIONS TO PARTICLE PHYSICS. Adler, Stephen L.; Dashen, Roger F. A Lecture Note and Reprint Series. Frontiers in Physics. New York, W. A. Benjamin, Inc., 1968. 407p.

An account is given of the progress made in particle physics in the last three years through the use of current algebra and the partially conserved axial vector current hypothesis. Significant reprints grouped according to subject matter are also presented. (J.F.P.)

**46349** DOES THE PROTON HAVE AN INTERNAL STRUCTURE? Barut, A. O. (Univ. of Colorado, Denver). Res. Rev. (Office Aerosp. Res.), 7: No. 4, 1-4(Apr. 1968).

A new theory is suggested for investigating the internal structure of fundamental particles, which complements field theory and S-matrix theory. Within this theory the composite structure of a system is described in terms of the behavior of observed global quantum numbers, rather than in terms of a purely space-time distribution of matter. A new quantum number n is proposed for the proton, analogous to the principle quantum number of atomic physics. Within this framework, which starts from global quantum numbers, completely relativistic calculations of the properties of composite quantum systems can be given. Baryon levels and an assignment of the new quantum number n are shown. A theoretical mass formula based on a simple form of the theory is compared with the known particles for the I = ½, N = 1 levels. The assignment of meson quantum numbers and mass spectrum is also shown. The theory also explains the essential feature of the form factors, as well as magnetic moments and partial decay rates of metastable states. (L.B.S.)

**46350** VECTOR FIELDS AND CURRENT COMMUTATORS. II. Boulware, David G. (Univ. of Washington, Seattle). Contract AT(45-1)-1388B. Phys. Rev., 172: 1625-7(Aug. 25, 1968). (RLO-1388-B-526).

It was previously shown that divergence conditions are equivalent to current commutation relations. Some of the assumptions which are made are shown to follow from more fundamental postulates. (auth)

**46351** MAJORANA EQUATIONS FOR COMPOSITE SYSTEMS. Bisiacchi, G.; Budini, P.; Calucci, G. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 172: 1508-15(Aug. 25, 1968). (IC-67/80).

A relativistic wave equation for the description of a composite system with nonrelativistic internal motion is deduced from the Bethe-Salpeter equation. It is shown that when the internal motion can be described by algebraic methods, as in the case of the hydrogen atom, the proposed equation for the motion of the system as a whole (motion of the c.m.) is equivalent to a Majorana-type equation, free from the well-known difficulties such as a spacelike solution. The hydrogen-atom example is discussed in some detail. It is shown how its SO(4,1) spectrum-generating algebra contains the spin part of the generators of the Lorentz group. The solutions found to the Majorana-type equation, which is able to describe both discrete and continuum eigenstates, span a representation of an SO(4,2) algebra. (auth)

**46352** WAVE EQUATIONS FOR NEUTRAL PARTICLES OF ARBITRARY SPIN. Yee, D. D. H. (Polytechnic Inst. of Brooklyn). Phys. Rev., 172: 1539-42(Aug. 25, 1968).

The two-component wave equation of the type proposed by Case and Jehle for particles of finite mass and spin $\frac{1}{2}$ is reconsidered and generalized to arbitrary spin. It is shown that it is covariant under the full homogeneous Lorentz group. It is also shown that wave equations of this type can be quantized, using Weinberg's noncanonical procedure. (auth)

**46353** SELECTED TOPICS IN SOLID-STATE AND THEORETICAL PHYSICS. Proceedings of the Latin American School of Physics held in Caracas, 1966. Bemporad, Manuel; Ferreira, Erasmo (eds.). Latin American School of Physics. New York, Gordon and Breach Science Publishers, 1968. 481p. $27.50 Hardbound; $17.50 Paperback.

Ten lectures are presented; separate abstracts were prepared for seven. The three topics not abstracted for NSA deal with the kinetic theory of dense gases, the application of Green's function techniques to statistical mechanics, and the physics of metals. (L.B.S.)

*For abstracts of individual papers see: 46068, 46385, 46412, 46430, 46475, 46476, and 46508.*

**46354** POSSIBILITY OF A PARA-FIELD REPRESENTATION OF INTRINSIC DEGREES OF FREEDOM OF THE ISOSPIN OR STRANGENESS TYPE. Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 54: 1786-98 (June 1968). (In Russian).

The possibility of introducing intrinsic degrees of freedom of the isospin or strangeness type on basis of the Green-Volkov paracommutative relations is demonstrated. For this purpose it is proposed that all irreducible (separable) representations of parafermion relations of the second and third orders be considered and that the various internal states of the paraparticles be interpreted as states belonging either to the various irreducible representations of the relations or differing with respect to symmetry of the vector state indices. An explicit matrix transformation of the parafield to a system of two fields obeying "isotopic" symmetry is presented for the second order case. An electromagnetic interaction which violates this symmetry is introduced within the framework of parafield theory. In the third order case the classification of particle states is identical with the "strangeness" and "isomultiplets," classification. (auth)

**46355** COVARIANT ARBITRARY-SPIN WAVE FUNCTIONS AND HELICITY COUPLINGS. Caudrey, P. J.; Ketley, I. J.; King, R. C. (Univ. of Southampton, Eng.). Nucl. Phys., B6: 671-86(1968).

Arbitrary-spin wave functions are developed in a realization-independent manner for all polarization states and then given explicitly in a covariant notation. Vertex functions are parametrized in a way which leads automatically to the use of helicity couplings. Conversion tables relating covariant parity-conserving helicity couplings to more conventional tensor and spinor-tensor couplings are given. (auth)

**46356** GENERAL FERMION-FERMION SCATTERING IN THE COVARIANT FORMALISM. Kellett, B. H. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 56A: 1003-26(Aug. 21, 1968).

The general problem of fermion-fermion scattering is investigated in the covariant four-component spinor formalism. Invariant amplitudes free of kinematic singularities in both the energy and angle variables are found and the necessary equivalence theorems are given in detail. The Fierz transformation matrices are evaluated in order to obtain singularity-free amplitudes with manifest crossing symmetry. (auth)

## Electromagnetic

*Refer also to abstracts 45036, 46436, 46446, 46458, 46495, 46556, and 46558.*

**46357** (JINR-E2-3926) VECTOR DOMINANCE MODEL AND SUM RULES FOR THE HIGH-ENERGY PHOTON-NUCLEON INTERACTION. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 14p. (CONF-680809-14). Dep.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Within the vector dominance model the sum rules for the cross sections of vector-meson photoproduction and for the total cross sections of photon and meson interactions with nucleons are discussed. (auth)

**46358** COMPTON SCATTERING OF ISOVECTOR PHOTONS WITH NUCLEONS AND ALGEBRA OF FIELDS. Kato, Masaaki; Kawarabayashi, Ken (Tokyo Univ. Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1527-30(June 1968).

Low energy theorems for the forward Compton scattering amplitudes of isovector photons with nucleons are reproduced by calculating the tree diagrams based on a phenomenological Lagrangian method. The implication of the results is discussed in connection with the $\rho$-dominance hypothesis. (auth)

**46359** COMMENT ON THE p-n MASS DIFFERENCE. Matsumoto, Yasuo; Muta, Taizo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1565-8(June 1968).

The p-n mass difference is investigated as a function of the strong interaction renormalization constant of the nucleon, Z, in the simple model introduced by one of the present authors (T. M.). It is shown that the correct sign of the mass difference can be obtained for sufficiently small positive Z. (auth)

**46360** PHOTOPRODUCTION OF CHARGED PIONS AND THE SLOPE OF THE PION TRAJECTORY. Tomozawa, Y. (Univ. of Michigan, Ann Arbor). Nuovo Cim., 57A: 165-9(Sept. 1, 1968).

The forward peak in the photoproduction of charged pions at 5 to 16 GeV has been interpreted as being due to the exchange of a pion Regge trajectory. A conspiracy theory is examined, in which the slope of the pion trajectory is taken into account. (L.B.S.)

**46361** COMPARISON OF EXPERIMENTAL DATA ON SHOWERS HAVING ENERGIES OF SEVERAL HUNDRED GeV WITH SIMULATED SHOWERS CALCULATED BY MONTE-CARLO METHOD. Zelevinskaya, N. G.; Kotel'nikov, K. A.; Maksimenko, V. M. (Leningrad Inst. of Physics). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 362-4(Mar. 1968). (In Russian).

The random selection of simulated showers by the Monte Carlo method is an efficient way of obtaining model characteristics. The model assumes that an excited meson bundle that forms decays to $\pi$-mesons without emission of nucleons. It is assumed that the distribution of the number of generated $\pi$-mesons can be described by statistical theory. Two variants of the theory assume that the meson bundles do not move, and that the bundles do move according to the laws of hydrodynamics. Angles and momenta of the shower particles were selected at random for the static and hydrodynamic variants of the model. Both variants gave a smaller asymmetry factor than was observed experimentally. Neither of the model variants agreed completely with experiment. These calculations were preliminary in nature in order to develop the computer program. Other theoretical models of interaction at high energies are being looked at. (TTT)

**46362** NUCLEON FORM FACTORS IN TERMS OF RESONANCES. Alvarez-Estrada, R. F. (Junta de Energia Nuclear, Madrid). Nuovo Cim., 57A: 178-81(Sept. 1, 1968).

An account is given of a fit to the usual electromagnetic form factors of the proton and neutron. The hypothesis that the form factors may be fitted by multiplicative formulas is tested for electron-nucleon scattering. (L.B.S.)

**46363** CURRENT ALGEBRA AND PHOTOPRODUCTION OF PIONS. Bhatia, M. S. (Univ. of Windsor, Ont.); Narayanaswamy, P. Phys. Rev., 172: 1742-9(Aug. 25, 1968).

A low-energy theorem from current-algebra techniques is employed to derive an expression for the pion photoproduction amplitude which is shown to be gauge invariant. The low-energy predictions for the differential cross sections and the multipole amplitudes are analyzed extensively and compared with the ex-

perimental data. The predictions for the production of charged pions are in as good agreement with experimental data as those of dispersion theory are. However, the current-algebra predictions for $\gamma p \rightarrow \pi^0 p$ characteristically differ from other theoretical models, especially at threshold. Accurate low-energy experimental data for this process should therefore provide a test of the validity of the current-algebra approach. (auth)

**46364** SCALAR- AND TENSOR-TADPOLE CONTRIBUTION TO $K^0$-$K^+$ MASS DIFFERENCE. Patil, Sharashchandra H. (Univ. of Delhi). Phys. Rev., 172: 1528-31(Aug. 25, 1968).

A calculation of the scalar-meson "tadpole" gives the correct sign but too small a magnitude for $m_K - m_K^+$. As an alternative, a "tadpole" due to $2^+$ mesons is calculated. Here the concept of relating the trace of tensor currents to scalar mesons is introduced which makes the dispersion integrals for the tensor particle $2\gamma$ vertex convergent. Then the tensor tadpoles give $m_K^0 - m_K^+ \approx 0.1$ MeV, which has the correct sign but is too small in magnitude compared to the experimental value of 4 MeV. (auth)

**46365** MOTION OF A TIME-DEPENDENT HARMONIC OSCILLATOR, AND OF A CHARGED PARTICLE IN A CLASS OF TIME-DEPENDENT, AXIALLY SYMMETRIC ELECTROMAGNETIC FIELDS. Lewis, H. R. Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 172: 1313-15(Aug. 25, 1968). (LA-DC-9503).

A class of explicitly time-dependent invariants for time-dependent harmonic oscillators is used to construct simple and elegant representations of the general solution of the equations of motion. Then the results for the oscillator are used to derive representations of the general solution of the equations of motion for a charged particle moving classically in the axially symmetric electromagnetic field consisting of an arbitrarily time-dependent, uniform magnetic field, the associated induced electric field, and the electric field due to an arbitrarily time-dependent, uniform charge distribution. (auth)

**46366** RELATIONS BETWEEN PHOTOPRODUCTION OF HADRONS AND VECTOR-MESON PRODUCTION BY MESON–NUCLEON COLLISIONS BASED ON THE PHOTON–VECTOR–MESON ANALOGY MODEL. Iso, Chikashi; Yoshi, Hiroaki (Tokyo Inst. of Tech.). Ann. Phys. (N. Y.), 48: 237-53(June 2, 1968).

The relations among differential cross section, polarization, helicity density-matrix element and joint decay helicity density-matrix element in $\gamma + N \rightarrow$ ps meson + baryon and ps meson + $N \rightarrow$ vector meson + baryon processes are given under the photon–vector-meson analogy model, utilizing the crossing relation in high-energy and small-angle approximation. The relation between differential cross sections of $\gamma N \rightarrow \pi N_{33}$ and $\pi N \rightarrow V N_{33}$ processes is compared with the experimental results. (auth)

**46367** FINAL-STATE INTERACTIONS IN THE $K \rightarrow 3\pi$ AND $\eta \rightarrow 3\pi$ DECAYS. Parkinson, Michael (Syracuse Univ., N. Y.). Phys. Rev., 172: 1607-12(Aug. 25, 1968).

An integral equation is derived which should describe, to a good approximation, the results of any theory of the K and $\eta$ $3\pi$ decays. It is shown that present experimental information implies that one subtraction in this equation is not enough; instead, it is found that two subtractions are necessary in order for the equation to describe experiment correctly. It is observed that for the weak (K) and electromagnetic ($\eta$) decay processes leading to a $3\pi$ final state, the subtraction constants are identical, up to an overall normalization. A short discussion of the possible significance of this is given, although no definite conclusions are reached. Our analysis confirms the suggestion that $\pi\pi$ final-state interactions will appear only in quadratic terms in the $3\pi$ final state. (auth)

**46368** TESTS FOR $|\Delta I| \leq 1$ IN ELECTROMAGNETIC INTERACTIONS. Bergmann, Ernest E. (Princeton Univ., N. J.). Phys. Rev., 172: 1441-5(Aug. 25, 1968).

A brief survey is presented of possible experiments with up to three hadrons to test the hypothesis that $|\Delta I| \leq 1$ in electromagnetic interactions. The prime emphasis is upon experiments utilizing electron-positron storage rings. In a note added in proof, the survey is extended to colliding-beam experiments of the type $e^+ + e^- \rightarrow (2n + 1)\pi$. (auth)

**46369** PION ELECTROMAGNETIC FORM FACTOR. Truong, Tran N. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France); Mau, R. Vinh; Yem, Pham Xuan. Phys. Rev., 172: 1645-7(Aug. 25, 1968).

Expressions for the spacelike form factor and its phase in the timelike region are given in terms of the magnitude of the timelike form factor. A sum rule for the upper bound of the pion radius is given. (auth)

**46370** ELECTROMAGNETIC MASS DIFFERENCES AND REGGE PHENOMENOLOGY. Gross, David J. (Harvard Univ., Cambridge, Mass.); Pagels, Heinz. Phys. Rev., 172: 1381-9 (Aug. 25, 1968).

The electromagnetic mass differences of hadrons are examined by a phenomenological analysis of the forward virtual Compton amplitude. In addition to the usual elastic contribution, the contribution from $A_2^0$ Regge exchange for I = 1 mass differences and possible contributions from non-Regge behavior for this weak amplitude in the asymptotic region are considered in detail. In the approximation of neglecting the inelastic resonant spectrum in Compton scattering, the contribution of the pure Regge exchange to the subtraction term for any I = 1 mass difference can be related to a ratio of the $A_2^0$ residue functions (hence independent of the target) and the relevant elastic form factors. This analysis suggests that a large Regge contribution requires comparable longitudinal and transverse electroproduction cross sections at high energy for small spacelike virtual photon mass. The tadpole model is also examined from the observation that certain linear combinations of I = 1 mass differences with just the $A_2^0$ Regge pole removed can be formulated in terms of unsubtracted dispersion relations and are presumably satisfied by retaining just the elastic contribution. The F/D ratio that is calculated in this way for the tensor-meson couplings to baryons agrees with that obtained from high-energy experiments. From a superconvergence relation it is argued that there is a fixed pole in the helicity-flip crossed-channel Compton amplitude at J = 0, I = 1, the experimental consequences of which are discussed. (auth)

**46371** ANOMALOUS MAGNETIC MOMENT OF THE MUON. Kinoshita, Toichiro (Cornell Univ., Ithaca, N. Y. CERN, Geneva). pp 209-44 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

Recent improvements of the theory of muon magnetic moment are discussed in some detail. Analysis of the 4th-order radiative corrections to the muon magnetic moment, the determination of leading logarithmic terms of the 6th order radiative corrections to the muon magnetic moment, a method of calculating the remaining $\alpha^3$ terms, diagrams containing subdiagrams of the photon-photon scattering type, and hadronic contributions to the muon magnetic moment are covered. (J.F.P.)

**46372** SOME APPLICATIONS OF COHERENT STATES. Kibble, T. W. B. (Imperial Coll. of Science and Tech., London). pp 299-345 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

A brief survey of some of the general properties of coherent states, both for a single oscillator and for the electromagnetic field is given. The problem of the interaction of a charged particle with an intense electromagnetic wave, and particularly the conditions under which quantum mechanical and classical treatments may be expected to lead to the same results, is considered. It is shown that in experimentally interesting situations a classical treatment is normally quite sufficient. Finally, the application of coherent states to the infrared divergence problem of quantum electrodynamics is considered. (J.F.P.)

**46373** ELECTROMAGNETIC-MASS SUM RULES FROM EQUAL-TIME CURRENT COMMUTATORS. Bose, S. K. (Indian Inst. of Tech., Kanpur). Nuovo Cim., 56A: 1135-8(Aug. 21, 1968).

The electromagnetic-mass sum rules for baryon and pseudoscalar mesons are derived from equal-time commutators in current algebra. It is shown that only F-type currents can give the Coleman–Glashow relation and it is not necessary to postulate D-type octet currents for baryons. The method can be applied to mesons also for which D-type octet currents do not exist. (L.B.S.)

**46374** MULTIPLE SCATTERING OF FAST ELECTRONS IN THIN LAYERS. Braicovich, L.; Dupasquier, A. (Istituto di Fisica del Politecnico, Milan). Nuovo Cim., 56A: 1066-74 (Aug. 21, 1968).

The elastic incoherent multiple scattering angular distributions of fast electrons are calculated, in the case of low mean numbers of scatterings and in the small-angle approximation. The target atom is described with the Thomas–Fermi model and the single scattering cross section is calculated as suggested recently by Zeitler and Olsen. Results are given in the form of a universal function of the mean number of scatterings and of a suitable reduced angular variable. (auth)

**46375** PHOTOPRODUCTION OF MESON AND BARYON RESONANCES. Schmitz, N. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Naturwissenschaften, 55: 265-71(June 1968). (In German).

The experiments possible with electron accelerators fall into four categories: experiments for the reexamination of quantum electrodynamics at high energies, experiments for the study of the electromagnetic properties of nucleons and mesons, experi-

ments on inelastic electron–nucleon scattering, and experiments on the photoproduction of strongly interacting particles. Experimental results from cloud chamber studies on the production of resonances are reported in graphic and tabular form. Two models for the theoretical description of the photoproduction of the vector mesons $\rho$, $\omega$, and $\varphi$ are given and compared with the experimental results. (J.S.R.)

## Weak

*Refer also to abstracts 46446 and 46483.*

**46376** (IC–68/76) MODEL FOR LEPTONIC INTERACTIONS. II. IS THE PION THE INTERMEDIARY BOSON. Fronsdal, C. (International Centre for Theoretical Physics, Trieste (Italy)). Aug. 1968. 8p.

A suggestion by Schwinger to use a spinless boson as mediator of weak interactions is combined with a proposal by Nishijima to consider the weak interactions as second-order effects of an interaction with no first-order manifestations. It is then possible to identify the intermediary boson with the pion, although the existence of another scalar boson as an intermediary for weak interactions cannot be ruled out. In either case there is no resonance in high-energy neutrino scattering. If the interaction Lagrangian is odd under CP, then observable CP violation will occur in the third order, with qualitatively correct strength. (auth)

**46377** RADIATIVE CORRECTIONS TO LEPTONIC DECAYS OF HADRONS. Nakamura, Koichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 39: 1554-64(June 1968).

Conditions on the finiteness of the radiative corrections to all the leptonic decays of hadrons are investigated. These conditions imply cancellation of two divergent integrals in the final expression and convergence of certain integrals sensitive to the details of strong interactions. The first condition fixes the equal-time commutation relations of the space components of current. In the triplet fermion model, these commutation relations determine the charges of the fundamental fermions. It is not elucidated on what assumptions the second convergence condition is satisfied, but an argument is provided in its favor by means of a simple illustrative calculation. (auth)

**46378** NONLEPTONIC HYPERON DECAYS BASED ON THE COMPOSITE SCHEME. Murayama, Akihiro (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 39: 1546-53(June 1968).

Nonleptonic hyperon decays based on the composite scheme are re-investigated and a model is proposed which reproduces the main properties of the P-wave decays. (auth)

**46379** LOW-ENERGY THEOREM FOR RADIATIVE DECAYS OF HYPERONS. Leal Ferreira, J.; Soffer, J. (Univ. of Maryland, College Park). Nuovo Cim., 57A: 144-53(Sept. 1, 1968).

The leading term in an expansion of the exact amplitude for charged hyperon decays, $B \to B' + \gamma$ ($|\Delta S| = 1$), in powers of $\omega_\gamma$ is computed. It coincides precisely with the result of the pole model for the parity-conserving amplitude. The physical validity of the expansion is discussed. (auth)

**46380** TREATMENT OF VERTEX FUNCTIONS FOR PHYSICAL PIONS AND THE CALLAN–TREIMAN RELATION. Ademollo, M. (Harvard Univ., Cambridge, Mass.); Denardo, G.; Furlan, G. Nuovo Cim., 57A: 1-19(Sept. 1, 1968).

Starting from the Callan-Treiman relation between the $K \to \pi\mu\nu$ and $K \to \mu\nu$ amplitudes, the problem of the extrapolation from the soft-pion limit, where the prescription of current algebra holds, to the physical region for a general vertex function is analyzed using a sum rule formulation. The simplest analyticity properties are those exhibited in the pion energy at fixed three-momentum. The corresponding dispersive path, in the plane of the squared pion mass and of the momentum transfer, is a parabola depending on the external variables. The advantages of choosing the parabola of maximum curvature are discussed. In particular the case of $K_{l3}$ decay is studied and three possible independent sum rules are found, one of which represents a generalization of the Callan-Treiman result. The effect of a possible strange scalar meson is explicitly considered. (auth)

**46381** $\kappa$-MESON MASS AND WEAK-DECAY PARAMETERS FROM A STUDY OF $K_{l3}$ FORM FACTORS. Mackey, Jacob E.; McKisic, J. Michael; Scott, David M.; Wada, Walter W. (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Phys. Rev., 172: 1590-2(Aug. 25, 1968).

Current algebra, dispersion relations, and the postulate of a partially conserved vector current with which is associated a strangeness-carrying scalar meson $\kappa$ are employed to obtain the $K_{l3}$ form factors and other weak-decay parameters. The values $f_+(0) = 0.96$ and $|F_\kappa/F_\pi| \approx 0.1$ indicate that the SU(3) symmetry-breaking effect is negligibly small. The mass of the $\kappa$ meson is found to be greater than 1300 MeV, with a very large width for the decay $\kappa \to K + \pi$. It is concluded that the existence of the $\kappa$ meson as a physically observable particle is extremely doubtful. (auth)

**46382** DETERMINATION OF CABIBBO PARAMETERS FROM BARYON DECAYS. Nieh, H. T.; Nieto, Michael Martin (State Univ. of New York, Stony Brook). Phys. Rev., 172: 1694-6 (Aug. 25, 1968).

A comparison is made of Cabibbo theory to the experimental data on semileptonic hyperon decays. With a confidence level of 89%, the results are that the Cabibbo angle $\theta$ is $0.206 \pm 0.009$, the weak D/F ratio $\alpha$ is $0.662 \pm 0.018$, and the strangeness-changing axial-vector renormalization $\xi$ is $1.42 \pm 0.10$. (auth)

**46383** SOME RARE WEAK BARYON DECAYS. Bartl, A. (Univ., Tuebingen, Ger.). Z. Phys., 215: 34-8(1968).

With the soft-pion technique the form factors of the weak baryon decay $A \to B + \pi + l + \bar{\nu}_l$ are related to the form factors of $A \to B + l + \bar{\nu}_l$. The ratio of the decay rates of these two processes turns out to be of the order $10^{-4}$. (auth)

**46384** $K_{l3}$-DECAY FORM FACTORS, CURRENT ALGEBRA, AND SUBTRACTED DISPERSION RELATIONS. II. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., 172: 1532-6(Aug. 25, 1968).

Once-subtracted dispersion relations are used together with the algebra of currents and soft-pion techniques to investigate the form factors $f_i(t)$ which describe $K_{l3}$ decays. Particular attention is paid to the influence of S-wave $K\pi$ states, and results are obtained which depend explicitly on the S-wave phase shift. Various parametrizations of this phase shift are made in an effort to clarify the interdependence of the $K\pi$ scattering amplitude and the $K_{l3}$ form factors. It is found to be difficult to obtain a value for $\xi \equiv f_-(0)/f_+(0)$ which is not small and negative, while the momentum dependence of $f_-(t)$ may be quite rapid in some cases. (auth)

**46385** WEAK INTERACTIONS. Sommerfield, Charles M. (Yale Univ., New Haven). pp 301-47 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

A survey is first given of various types and basic properties of weak interactions. The remaining topics discussed are the world Hamiltonian, current-current interaction, muon-decay Hamiltonian, invariance under P, C, and T, structure of hadron currents in weak interactions, and SU(3) symmetry. (L.B.S.)

**46386** PHENOMENOLOGICAL LAGRANGIAN FOR NONLEPTONIC WEAK INTERACTIONS. Vanyashin, V. S. (Univ., Rome). Nuovo Cim., 56A: 1117-21(Aug. 21, 1968).

A method of obtaining the weak hadronic Lagrangian for nonleptonic weak interactions from the strong-interaction Lagrangian is illustrated. Some specific results in the cases of s-wave hyperon decays, K decays, and weak radiative hadronic decays are given. (L.B.S.)

**46387** DECAY SPECTRUM OF POLARIZED MUONS IN THE GENERAL FERMI INTERACTION. Florescu, V.; Kamei, O. (CNRS, Paris). Nuovo Cim., 56A: 967-82(Aug. 21, 1968).

A general expression for the decay spectrum of the polarized muon is obtained assuming the general Fermi interaction with radiative corrections. This permits the decay spectrum to be discussed with 1% accuracy. New parameters $\varphi$ and $\kappa$ are introduced to display the deviation from the V, A interaction. The measurement of these parameters is not much more difficult than that of the usual low-energy parameter $\eta$, but is cut-off dependent. (auth)

## Strong (General)

**46388** BOOTSTRAP: A SCIENTIFIC IDEA. Chew, Geoffrey F. (Univ. of California, Berkeley). Science, 161: 762-5 (Aug. 23, 1968).

A review is given on the scientific status of the bootstrap hypothesis, both from the broad point of view and from the limited point of view which concerns hadrons only. (L.B.S.)

**46389** LARGE ANGLE SCATTERING IN QUARK MODEL. Takada, Yoshio (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto), 39: 1536-45(June 1968).

Quark model is applied to high energy elastic scattering, assuming the "additivity assumption" to the quark-quark scattering phase shift. It is shown that the Krisch-type parametrization of proton-proton elastic scattering can be derived from this model and that dips, the energy dependence of the height of the second maximum and the tendency of antishrinkage of the width of the

forward diffraction peak in the antiproton-proton elastic scattering differential cross section can also be explained. (auth)

**46390** THIRD SECTOR OF THE LEE MODEL. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 172: 1429-40(Aug. 25, 1968).

The third sector of the Lee model is studied. The model is augmented by a third static source U in addition to N and V, with the coupling $U \rightarrow V + \theta$. In the third sector the processes $U + \theta \rightarrow V + \theta + \theta \rightarrow N + \theta + \theta + \theta$ occur, providing a model enriched with a two-particle channel. Using the methods of dispersion theory, the dynamics are reduced to the solution of a Fredholm integral equation in one variable. A variational principle is given for the equation which yields the elastic scattering amplitude. Diagonalization of the second-sector connected S matrix plays an important part in the analysis. Finally, the relevance of the results to static models with crossing—specifically, to a three-meson solution of the charged-scalar static theory is discussed. (auth)

**46391** GENERAL FORM OF REPRESENTATIONS OF THE CURRENT ALGEBRA IN THE TWO-QUARK MODEL. Hill, Roger C. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 172: 1521-7(Aug. 25, 1968). (CALT-68-152).

The algebra of vector and axial-vector charge densities at infinite momentum is solved (disregarding relativistic invariance), giving the most general form of these densities in the two-quark model of the mesons. The possibility of these solutions satisfying the angular condition for relativistic invariance is considered, and for SU(3) currents it is found that if a covariant solution cannot be found in the simple case where the current is a sum of contributions from each quark and the mass of the two-quark system is SU(3)-independent, then no covariant SU(3)-symmetric solution of the current algebra can be found in this model, even with a singlet-octet mass splitting. (auth)

**46392** COMPOSITENESS CONDITIONS IN BRONZAN'S VERSION OF THE LEE MODEL. Liossatos, P. S. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 172: 1554-63(Aug. 25, 1968).

The Lee model with the additional coupling $U \rightleftharpoons V + \theta$ is examined in the limit as $Z_V \rightarrow 0$, where $Z_V$ is the wave-function renormalization constant of the V particle. The S matrix in the $N\theta$ and $V\theta$ sector, the U-particle propagator, and the $UV\theta$ vertex are shown to exist as $Z_V \rightarrow 0$, and their limits are displayed explicitly. In particular, it is proved that the irreducible part of the $V\theta$ scattering amplitude, describing the $V\theta$ scattering in the ordinary Lee model, becomes identical to the $N\theta$ scattering amplitude in the $Z_V \rightarrow 0$ limit, regardless of the speed with which the cutoff function approaches zero as the energy tends to infinity. The most important result presented here is that the $UV\theta$ vertex, taken in the $Z_V \rightarrow 0$ limit, tends to twice the vertex renormalization constant as the $\theta$-particle energy goes to infinity; this is at variance with presently accepted conjecture. Futhermore, the following equivalence theorem is established: The Lee model with the additional coupling $U \rightleftharpoons V + \theta$ in the limit of vanishing $Z_V$ is equivalent to a composite model containing only the U, N, and $\theta$ particles interacting via the four-point interactions $U \rightleftharpoons N + \theta + \theta$, $N + \theta \rightleftharpoons N + \theta$, and $U + \theta \rightleftharpoons U + \theta$. (auth)

**46393** ALGEBRA OF MESON CURRENTS IN A MODEL OF FREE EFFECTIVE QUARKS. Shelest, V. P. (Inst. of Theoretical Physics, Kiev). Dokl. Akad. Nauk SSSR, 181: 64-7(July-Aug. 1968). (In Russian).

An attempt was made to show that within the limits of the model of free effective quarks it is possible to prove the applicability of meson current algebra relations for any arbitrary mode of expansion according to inverse meson mass. In the effective quark model the meson is considered as a strongly bound state of quark and antiquark with large masses, moreover these masses are compensated mainly by a strong intra-hadron interaction which may be interpreted as a certain self-consistent field. The excess of quark mass equal to the hadron mass is assumed to be related to certain effective formations in hadrons moving quasi-independently in the field. Interactions between quasi-independent quarks are rare and may be excluded from the investigation and only the model of free effective quarks is considered. A meson consisting of an effective quark with the mass $\underline{m}_1$ and antiquark with mass $\underline{m}_2$ with momentum $\underline{l}^1$ and $\underline{l}^2$ respectively are analyzed. (R.V.J.)

**46394** QUARK MODEL AND MASSES OF BARYONS AND MESONS. Misra, S. P.; Sastry, C. V. (Regional Engineering Coll., Rourkela, India). Phys. Rev., 172: 1402-6(Aug. 25, 1968).

The procedure here, in addition to taking the usual additivity of amplitudes in the quark model, consists of the following: (i) the expectation values of the matrix elements of the potential for the appropriate quark wave function give us the corrections to the mass matrix; (ii) the amplitudes of the matrix elements of the potential can be analytically continued from the quark–quark to the quark–antiquark channel to describe mesons; (iii) the bound-state quark wave functions are assumed to exist and within a multiplet the quark wave functions do not differ widely; (iv) there is a $T_3^8$ type of mass breaking in quark–quark space. The results are in good agreement with experimental data. (auth)

**46395** REGGEIZATION OF QUARK NUMBER. Delbourgo, R. (Imperial Coll. of Science and Tech., London); Salam, Abdus; Strathdee, J. Phys. Rev., 172: 1727-36(Aug. 25, 1968). (IC-68/14).

In earlier work the Reggeization of approximate dynamical groups has been presented as a calculational method for classifying particles and evaluating S-matrix elements at high energies. In continuation of this work, an especially simple model is considered where just one invariant of the higher $U(6) \times U(6)$ approximate symmetry, quark-plus-antiquark number, is Reggeized. The resulting classification of particles (according to their quark content) into exploding supermultiplets of spin and unitary spin, and the formulas for computing S-matrix elements, are given for high energies, where an exchange of an N-plane trajectory in the cross channel may be expected to dominate the scattering. The hope is that this analysis may help reduce the large number of parameters now used in Regge theory by combining Regge ideas with higher symmetries. The type of Fourier expansion on a higher approximate symmetry group and the Regge technique used here for evaluating asymptotic behavior may possess wider applications than the case considered. (auth)

**46396** HADRONIC MATTER NEAR THE BOILING POINT. Hagedorn, R. (CERN, Geneva). Nuovo Cim., 56A: 1027-57 (Aug. 21, 1968).

Hadron collisions above ~10 GeV/c primary laboratory momentum show an interesting global aspect (i.e. when averaged over all final channels): they can be described as a superposition of a rather special form of thermodynamics and of the kinematics of collective motions in the forward-backward direction. The thermodynamical behavior is similar to that of boiling; the boiling temperature $T_0$ is not exactly known but near to 160 MeV; its value and the whole thermodynamic behavior of hadronic matter follow uniquely from the hadronic mass spectrum. Namely, in this model, as a consequence of a king of asymptotic bootstrap involving all hadrons, the mass spectrum of hadrons turns out to grow necessarily like $\exp[m/T_0]$ where $T_0$ is the highest possible temperature (boiling point of hadronic matter). Global aspects of hadron collisions from ~10 GeV/c up to the highest cosmic-ray primary momenta (>$10^5$ GeV/c) namely: production rates, differential momentum spectra of secondaries, transverse-momentum distributions, etc., agree well with the calculations based on this model. The known part of the hadronic mass spectrum does indeed grow exponentially and the mean transverse momenta of pions produced between 10 and $10^5$ GeV/c primary momentum correspond to $T \approx 120$ to 160 MeV. The following speculative picture emerges: there seems to exist a highest temperature (or boiling point of hadronic matter) $T_0 \approx 160$ MeV; hadronic matter in collisions above some ten GeV/c primary momentum is in a state where all hadrons melt by way of a universal hadronic bootstrap, into "boiling hardonic matter" in which strong collective motions in the direction of the collision axis coexist with local thermodynamical equilibrium. (auth)

**46397** MULTIPLE-SCATTERING CORRECTIONS TO POMERANCHUKON EXCHANGE. Frautschi, S.; Margolis, B. (CERN, Geneva). Nuovo Cim., 56A: 1155-63(Aug. 21, 1968).

The slope of the Pomeranchukon trajectory used to fit the forward peaks of high-energy elastic scattering is reexamined, taking account of multiple-Pomeranchukon exchange corrections, and incorporating the current theoretical idea that the leading trajectories may be approximately linear over the observed range of momentum transfer t. The inclusion of multiple scattering supports the possibility that the Pomeranchukon has a normal slope ($\alpha_P' \sim 1(\text{GeV})^{-2}$). The model with this slope is consistent with gross features of pp, $\bar{p}p$, $\pi p$, and Kp elastic-scattering data. (L.B.S.)

## *Strong (Baryon No. = 0)*

*Refer also to abstracts 46389, 46430, and 46467.*

**46398** (DESY-68/37) EQUAL-TIME COMMUTATORS OF NONCONSERVED CURRENTS IN RENORMALIZABLE FIELD THEORIES. Stichel, P. (Physikalisches Staatsinstitut, Hamburg (West Germany). Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). July 1968. 12p. Dep.

The existence of equal-time commutators between properly defined nonconserved charges is examined in perturbation theory. As a model axial-charges within different versions of renor-

malizable field theories describing the interaction of $\pi$- and $\sigma$-mesons are considered. Renormalized vector- and axial-vector currents are constructed in such a way that they satisfy in the free field case Gell-Mann's SU(2) × SU(2) current algebra. In second order perturbation theory the existence of equal-time limits depends strongly on the kind of interaction. In the case of quadrilinear couplings such as $L_{int} = g^2\vec{\pi}^2\sigma^2$ the equal-time limit of axial-charge commutators does not exist. Trilinear couplings or a particular combination of quadrilinear and trilinear couplings (Gell-Mann-Levy type coupling) lead to no difficulties. In the latter cases the form of axial-charge commutators is in agreement with Gell-Mann's hypothesis. (auth)

**46399** MASS RELATIONS FOR $1^-$ AND $1^+$ NONETS BASED ON WEINBERG'S SUM RULES. Kawarabayashi, Ken; Kitakado, Shinsaku (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1531-5(June 1968).

A mass relation among isospin singlets of $1^+$ and $1^-$ nonets is obtained by making use of Weinberg's sum rules based on asymptotic U(3) ⊗ U(3). Possible existence of the ninth member of $1^+$-nonet is suggested and its mass is predicted from this relation. (auth)

**46400** REGGE MODEL FOR DOUBLE CHARGE-EXCHANGE PROCESSES. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 57A: 174-7(Sept. 1, 1968).

A simple model is presented along the lines of the Reggeized absorption model for describing double charge-exchange scattering. The model is applied to the calculation of the differential cross section for $K^- + p \to K^+ + \Xi^-$ scattering at t = 0. (L.B.S.)

**46401** CONSTRUCTION OF A CROSSING-SYMMETRIC, REGGE-BEHAVED AMPLITUDE FOR LINEARLY RISING TRAJECTORIES. Veneziano, G. (CERN, Geneva). Nuovo Cim., 57A: 190-7(Sept. 1, 1968).

A simple expression is proposed for the relativistic scattering amplitude, which obeys the requirements of Regge asymptotics and crossing symmetry in the case of linearly rising trajectories. The expression contains automatically Regge poles in families of parallel trajectories (at all t) with residue in definite ratios. It furthermore satisfies the conditions of superconvergence and exhibits the duality between Regge poles and resonances in the scattering amplitude. The following examples are discussed: $\pi\pi \to \pi\omega$ and $\pi\eta \to \pi\rho$ scattering. (L.B.S.)

**46402** MODIFIED DISPERSION RELATIONS AND $\pi\pi$ SCATTERING. George, David J.; Hale, Barbara; Tubis, Arnold (Purdue Univ., Lafayette, Ind.). Phys. Rev., 172: 1740-2(Aug. 25, 1968).

The $\pi\pi$ S-wave scattering-length predictions of Weinberg were tested by using dispersion sum rules for the infinite-energy cross section. Reasonable agreement is obtained with the infinite-energy cross section (≈15 mb) estimated from the factorization theorem for the Pomeranchon Regge residues. Experimental phase-shift data of Gutay et al., Walker et al., and Baton et al. are used in estimating the dispersion integrals. The analysis seems to rule out an I = 0 S-wave scattering length $\gtrsim 0.4\mu^{-1}$. (auth)

**46403** ACCURATE SOLUTION OF A BETHE-SALPETER EQUATION FOR A FERMION-ANTIFERMION SYSTEM BOUND VIA VECTOR EXCHANGE. Narayanaswamy, P. (Tata Inst. of Fundamental Research, Bombay); Pagnamenta, Antonio. Phys. Rev., 172: 1750-4(Aug. 25, 1968).

The Bethe-Salpeter equation for a bound state of two spin-½ particles is reduced to a form which is tractable numerically. It is found that the presence of two spin-½ propagators makes the introduction of a cutoff necessary. This is done in such a way as to guarantee the Wick rotation. Eigenvalues of the mass and coupling constants are given for the states of spin-parity $0^-$ and $1^-$. The applicability of the Bethe-Salpeter equation to a quark-antiquark system is discussed. (auth)

**46404** MODEL FOR PION S-WAVE PHASE SHIFTS FROM CURRENT ALGEBRA AND PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT. Amatya, A. M. S. (Tait Inst. of Mathematical Physics, Edinburgh); Pagnamenta, A.; Renner, B. Phys. Rev., 172: 1755-60(Aug. 25, 1968).

From the algebra of axial-vector charges and divergences, using extensively the principle of pion-pole dominance, a set of sum rules is derived for ($\pi\pi$) S-wave interactions in the isospin-zero channel. In a single-particle approximation, they provide information on the conjectured $\sigma$ meson. In the approximation of elastic unitarity, the sum rules take the form of an integral equation for a vertex function $\langle\pi|\sigma|\pi\rangle$, which leads to the inequality $0 < \delta_0 < \pi$ for the ($\pi\pi$) S-wave phase shift $\delta_0$ in the isospin-zero channel, whenever it is approximately valid. Exact solutions of the approximate integral equation, however, cannot be constructed, and an effective cutoff function is introduced as a correction to the approximation of the partial conservation of axial-vector current. The solutions for $\delta_0$ give a scattering length slightly larger than Weinberg's result and a broad maximum of the phase shift around 700 MeV; its height is sensitive to the cutoff parameter. (auth)

**46405** ($K\pi$) PHASE SHIFTS FROM A CURRENT-ALGEBRA MODEL. Pagnamenta, Antonio (Rutgers, The State Univ., New Brunswick, N. J.); Renner, B. Phys. Rev., 172: 1761-3(Aug. 25, 1968).

An earlier model for ($\pi\pi$) S-wave phase shifts from current algebra and partially conserved axial-vector current is extended to the ($K\pi$) S-wave phase shifts in the isospin-½ channel. The solutions depend on a cutoff parameter and give the scattering length in the range $0.12/m_\pi - 0.18/m_\pi$, a broad maximum of the phase shift in the range 1200-1500 MeV, and a slow decrease to zero at higher energies. The height of the maximum is cutoff-dependent; its value has been estimated by requiring saturation of the ($K\pi$) Adler-Weisberger relation. The results are applied to give information on the form factors of $K_{\mu 3}$ decay. In particular, $\xi \approx -0.15$ is found. (auth)

**46406** FEYNMAN-DIAGRAM MODELS OF REGGE-POLE CONSPIRACIES. Blankenbecler, R. (Univ. of California, Santa Barbara); Sugar, R. L.; Sullivan, J. D. Phys. Rev., 172: 1451-61(Aug. 25, 1968).

Two different Feynman-diagram models of Regge poles are used to study the conspirator trajectories which arise in the scattering of particles with spin. The process $\rho\rho \to \pi\pi$ is studied in detail. It is shown how the class-II and class-III conspiracies which can and do occur are related to different possible couplings of the $\pi\rho$ system to spin-J states. The influence of such conspiracies on the s-channel helicity amplitudes is emphasized. The methods used can be applied to the scattering of particles with arbitrary spins. (auth)

**46407** DIFFRACTIVE $2\pi$ PRODUCTION AND $\pi$-$\pi$ INTERACTIONS. Nussinov, S. (Princeton Univ., N. J.). Phys. Rev., 172: 1446-50(Aug. 25, 1968).

It is shown that diffractive production reactions of the type $\pi X \to 3\pi X$ may serve as a useful source of information on $\pi$-$\pi$ interactions. An analysis of the available experimental information is made using two simple models for the diffractive production. The results indicate the absence of a strong "$\pi$" $\to 3\pi$ vertex with a completely symmetric isospin coupling. This suggests that $\sigma$ terms do not contribute much more than $(0.3-0.4)m_\pi^{-1}$ to the $a_0$ scattering length. (auth)

**46408** O(4), OFF-SHELL $N\bar{N}$ SCATTERING, AND MASSLESS PIONS. Mueller, A. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 172: 1516-21(Aug. 25, 1968).

An O(4) formalism for off-shell $N\bar{N}$ scattering at t = 0 is developed which diagonalizes the Bethe-Salpeter equation into O(4) components. The $N\bar{N}$ scattering potential due to single pseudoscalar meson exchange is explicitly reduced into its O(4) components. Symmetry properties of the O(4) amplitudes due to the requirements of C and P invariance are exhibited. The off-shell $N\bar{N}$ scattering amplitude at t = 0 is found to have six distinct types of Lorentz poles, in contrast to the three types found by Freedman and Wang for the on-shell problem. It is shown that massless pions of the type found by Nambu and Jona-Lasinio have the definite O(4) quantum numbers n = 0, M = 0. It is further argued that M = 1 massless pions are impossible and that Regge trajectories belonging to M = 1 Lorentz poles choose nonsense when j goes through zero. (auth)

**46409** PARITY DOUBLING FOR BOSONS AND M = 1 PROPAGATORS. Alessandrini, V. A. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 172: 1503-7(Aug. 25, 1968).

A field-theoretic projection operator for integer spin J with a "Toller" quantum number M = 1 is constructed. It is shown in a specific example that its use, either in the context of the Van Hove model or to generate partial-wave expansions for the scattering amplitude, yields naturally the phenomenon of parity doubling for boson Regge trajectories. (auth)

**46410** PHASE-SPACE DISTRIBUTIONS FOR THE $4\pi$ DECAY MODE OF ISOSINGLET BOSONS. Nelson, T. J. (Ames Lab., Iowa). Phys. Rev., 172: 1701-26(Aug. 25, 1968). (IS-1744).

Phase-space distributions for the decay of an isosinglet resonance into four pions are developed. Such resonances have been observed in the final state of the reaction $p + \bar{p} \to 2\pi^+ + 2\pi^- + \pi^0$, for example. The spin and parity of the resonance are of primary interest. States of four pions that observe Bose statistics and have zero isotopic spin divide into two symmetry types. In this paper, the distributions are developed phenomenologically from the simplest possible T matrix for each parity and symmetry and for spins zero, one, and two. In general, eight variables characterize the four-particle decay problem. To facilitiate the experimental determination of the spin, parity, and symmetry type, partial

integrations of the distributions are performed analytically. The remaining variables are the two-particle invariant masses of the Goldhaber triangle and angles. One of the angles orients the plane of two of the pions with respect to that of the other two. The distribution in this angle alone provides a significant partial identification of the quantum numbers of the resonance. For spins one and two, two more angles which specify an external direction have been retained. In the reaction $p + \bar{p} \rightarrow 2\pi^+ + 2\pi^- + \pi^0$, the resonance-plus-pion system has been observed to be preferentially aligned with the beam direction. If production takes place equally from the four initial spin states, and if the spin of the resonance is not zero, then conservation of angular momentum along the beam direction results in anisotropy in the decay products. When available, this anisotropy may be a sensitive test of the spin and parity of the resonance. Plots of the unpolarized distributions over the Goldhaber triangle are presented to aid further in making spin-parity assignments. (auth)

**46411** BOOTSTRAP SOLUTIONS OF THE BETHE–SALPETER EQUATION. Kaufmann, William B. (Univ. of California, Berkeley). Phys. Rev., 172: 1697-1701(Aug. 25, 1968). (UCRL-18069).

Solutions to the Bethe–Salpeter bootstrap equations are found, in the sense that the exchanged particle and the composite state have the same mass and coupling constant to the external (i.e., bound) particles. One solution predicts a (nonexistent) $\pi\pi$ bound state at $1.6m_\pi$, and also provides a possible model for the $\eta_N(1070)$ state. The method of calculation is numerical and utilizes the Schwinger variational principle. (auth)

**46412** SELECTED TOPICS ON BOSON RESONANCES. Goldhaber, Gerson (Univ. of California, Berkeley). pp 103-69 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

Some of the experimental aspects of discovering and analyzing resonant states are reviewed in section 1. Topics discussed include resonance decays into two and three particles, double resonance production, the Chew-Low plot, the normalized Dalitz plot, angular distribution, and momentum transfer distribution. A new method is described in section 2 for the utilization of the Dalitz plot designed to facilitate the search for the existence of new three-particle resonances and the determination of their quantum numbers. The SU(3) classification of the $0^-$ nonet of particles and the $1^-$ and $2^+$ nonets of resonances is treated in section 3. Section 4 treats the question of whether the $A_1$ phenomena is a meson or a kinematical enhancement. References are given at the end of each section. (L.B.S.)

**46413** BOOTSTRAP MODELS FOR REGGE-TRAJECTORIES. Dietz, K.; Honerkamp, J.; Kupsch, J. (Univ., Bonn. Kernforschungsanlage, Juelich, Ger.). Nucl. Phys., B6: 639-48(1968).

The question of constructing Reggeized amplitudes which can be used for time-like and space-like momentum transfers is discussed. Several models are given which result in general in quite different bootstrap equations. The model of daughter-like solutions to the problem (Class I in the language of O(3,1) or O(4)) is compared to the usual ansatz in the simple cases of $\pi\pi$ and $\eta\eta$ scattering. (auth)

**46414** DO WE REALLY UNDERSTAND THE $A_1\rho\pi$ SYSTEM? Kuti, J. (Roland Eoetvoes Univ., Budapest). Nucl. Phys., B6: 655-61(1968).

It is shown, by assuming the dominance of nearby singularities in subtracted dispersion relations, that the calculation of $A_1\rho\pi$ couplings goes beyond the informations extracted from current-commutator algebras or divergence equations. The results are compared with present data on the $\rho_0 \rightarrow \mu^+\mu^-$, $A_1 \rightarrow \rho\pi$, and $\rho \rightarrow \pi\pi$ decays, the pion charge radius and the axial vector structure radiation of charged pions. (auth)

**46415** CURRENT-DENSITY, CURRENT-DENSITY COMMUTATION RELATIONS AND THE VVP COUPLINGS. Lai, C. S.; De Souza, P. D. (Indiana Univ., Bloomington). Nucl. Phys., B6: 649-54(1968).

Using a limiting procedure due to Bjorken, the VVP couplings are related to the current density-current density commutators. It is then found that the Gell–Mann, Sharp and Wagner pole model is valid only in the algebra of fields, whereas in the algebra of currents the VVP couplings are momentum-dependent. (auth)

**46416** DIRECT EVIDENCE FOR THE ASSIGNMENT OF ZERO SPIN TO THE PI-MINUS MESON. Carrigan, R. A. Jr. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Phys., B6: 662-70(1968).

The possibility of ordinary fine structure in pi-mesic X-rays is examined by directly comparing pion and muon X-ray lines for the same element. It is shown that the broadening of a typical pion line allows a pion magnetic moment no greater than 0.3 pion Bohr magnetons. Additional considerations indicate that the observed broadening is more consistent with nuclear absorption broadening than a line split by fine structure. From this, it is concluded that the g-value and the spin of the negative pion is zero, consistent with the experimental value for the positive positive pion. In addition, an upper limit of from 5 to 15% is found for X-rays from particles other than pions in the beam with masses near the mass of the pion. (auth)

**46417** EXISTENCE OF A $\kappa$-MESON FROM THE SPECTRAL-FUNCTION SUM RULES. Kang, K. (Argonne National Lab., Ill. Brown Univ., Providence). Nuovo Cim., 56A: 1147-9(Aug. 21, 1968).

A new theoretical speculation of the mass and decay constant of the strangeness-carrying isospinor $\kappa$ -meson is reported. The method is based on the Weinberg first sum rule for $SU_3 \times SU_3$, the second sum rule, and a new sum rule that was previously reported for $SU_2 \times SU_2$ only. (L.B.S.)

**46418** REMARKS ON THE BARYON TRAJECTORIES. Minami, S. (Osaka City Univ.). Nuovo Cim., 56A: 1139-41 (Aug. 21, 1968).

A relation expressing the symmetry property between $\alpha$ octet and $\gamma$ octet trajectories with the same Y and I is pointed out. The existence of new resonances and the spin-parity of observed resonances whose quantum numbers have not been established are predicted on the basis of the symmetry properties of the octet trajectories. (L.B.S.)

**46419** CORRECTION TO THE POTENTIAL IN BORN APPROXIMATION ARISING FROM DIRECT-CHANNEL STRIPS. II. DerSarkissian, M. (Temple Univ., Philadelphia). Nuovo Cim., 56A: 1058-65(Aug. 21, 1968).

The $\pi\pi$ partial wave amplitude (pwa) is studied in the one-channel approximation for the state I = I = 1. The Born approximation to the force operating in the direct channel is assumed to be saturated by $\rho$-exchange in the crossed reactions for this state. This amounts to a "strip approximation" to the force. However, the direct channel strips must also contribute to the potential and there are two relatively simple ways to estimate this effect. The first was treated in a previous paper and involved putting an asymptotic constraint on the pwa, $B^1_1(\nu) \equiv A^1_1(\nu)/\nu^1$, which has the threshold factor divided out. The correction to the Born approximation was an attractive force in the state I = I = 1. The second method is the subject of this paper and involves working with the pwa, $A^1_1(\nu)$, and imposing on it the usual threshold constraint. The correction to the Born approximation in this case is a strong repulsive force. The two methods give qualitatively very different effects in $\pi\pi$ scattering, although the present method is probably more reliable. We finally show how to relate the two corrections at low energies. (auth)

**46420** FINITE-ENERGY SUM RULES FOR MESON–MESON SCATTERING. Costa, G.; Savoy, C. A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 56A: 1168-72(Aug. 21, 1968).

Finite-energy sum rules are applied to $\pi$-$\pi$, $\pi$-K, $\pi$-$\rho$, and $\pi$-K* systems. Zero-moment sum rules are used to obtain information about the couplings of the Regge $\rho$-trajectory. These sum rules are saturated in the resonance approximation, using experimental data. Negative-moment sum rules are also used to obtain information on the boson states. (L.B.S.)

## *Strong (Baryon No. = 1)*

*Refer also to abstract 46357.*

**46421** (JINR-P2-3931) ON THE $\gamma$-QUANTA SPECTRUM IN THE REACTION $\pi^-p \rightarrow \pi^-p\gamma$. Tkebuchava, F. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. (In Russian). Dep.

The $\gamma$-quanta spectrum, which is emitted at $\pi^-p$-scattering is considered within the previously developed model. Interference of the pole diagrams is calculated and the pole approximation error is estimated. (auth)

**46422** (NP-tr-1692) THE POSSIBILITY OF MEASURING THE MAGNETIC MOMENT OF THE ISOBAR $\Delta^{2+}(1236)$ IN RADIATIVE $\pi^+p$ SCATTERING. Kondratyuk, L. A.; Ponomarev, L. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report ITEF-528. 16p. Dep. CFSTI. UK.

Handwritten MS Copy.

A method is described for measuring the magnetic moment of the isobar $\Delta^{++}(1236)$ in the process $\pi^+p \rightarrow \pi^+p\gamma$. The differential cross section for this process was determined for an incident pion energy close to the resonance energy, for $\gamma$ quanta at large

angles $\Theta_1$ and $\Theta_2$ relative to the directions of the two pions. It is shown that the values of $d\sigma/d\omega$ with and without allowance for the magnetic moment of $\Delta^{++}$ may differ by an average factor of 2 in the $\gamma$ quantum energy range 30 MeV $< \omega < \omega_{max}$ and the angle range $135° < \Theta_1, \Theta_2 < 180°$, if $\mu_\Delta = 2\ \mu_p$ as predicted by SU(6) symmetry. The value of $d\sigma/d\omega$ itself is found to be $\sim 10^{-30}$ cm$^2$/100 MeV. An estimate of background is also made. (auth)

**46423** (UCRL-18271) IS THERE EVIDENCE FOR AN H MESON? (IS IT JUST THE $\eta'$?) Barbaro-Galtieri, A.; Soeding, P. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1968. Contract W-7405-eng-48. 24p. (CONF-680428-10). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

Analysis of $\pi^+p$ and $\pi^+n$ data, in the 3- to 4-GeV/c incident $\pi^+$ momentum range, shows that at present there is no convincing evidence for existence of the so-called H meson ($M \approx 990$ MeV, suggested quantum numbers $I^G J^P = 0^-1^+$). The enhancement observed in the neutral three-pion invariant mass distribution near 990 MeV can be attributed to the $\pi\pi\gamma$ decay mode of the $\eta'$. (auth)

**46424** MULTIPARTICLE INTERACTIONS IN THE HIGH- AND SUPER-HIGH ENERGIES (NEW TYPES OF ELEMENTARY PARTICLE INTERACTIONS). Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 350-1(Mar. 1968). (In Russian).

Experiments on inelastic collisions of high-energy particles with nuclei can give information on multiparticle interactions. The secondary particles which are formed during the inelastic $\pi$N- or NN-interaction are emitted at a very narrow solid angle, and the resulting nucleon immediately captures or scatters a number of these particles. Cascade computer calculations by the Monte Carlo method then give information on the interaction. At energies T > 1 GeV it is noted that a separate particle carrying away about 50% of the total energy exists independently, that the angular distribution of the particles is asymmetric with the asymmetry depending on the type of generated particles, that the average particle energy and number increase approximately as $T^{0.25}$, and that a total of 10 to 20% heavy particles on the average are formed at very high energies. The energy and angular distributions are given for total energies of 5, 20 and above 30 GeV. Accurate measurements at 60 to 70 GeV on the cyclotron at Serpukhov are required for a more detailed study. The contribution of many-particle interactions is large in the case of light nuclei. For example, at T = 100 GeV the fractions of many-particle interactions for light, average and heavy nuclei are 38, 30 and 28% respectively. (TTT)

**46425** EXPONENTIAL TYPE RESIDUE IN REGGE POLE ANALYSIS OF THE PROCESS $\pi^+p \to \pi^0\Delta^{++}$. Yoshida, Toshihiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1603-4(June 1968).

The previous conjecture that for small-angle scattering the s-dependence of the scattering amplitude is determined by the Regge behavior of the exchanged composite system and the t-dependence by the compositeness of the participating hadrons is considered. It is shown that this conjecture holds also for quasi-two-body processes, and that data on the differential cross section can be reproduced with the value of $(\sqrt{\langle r^2 \rangle})$, the rms radius of the composite hadron, of about 3 $(\text{GeV/c})^{-1}$, as previously found. The process $\pi^+ + p \to \pi^0 + \Delta^{2+}$ is investigated because only the $\rho$-trajectory is exchanged in this process. It is concluded that the studied process can be reproduced well with the exponential-type residue function. (J.F.P.)

**46426** ROLE OF $K^*$ EXCHANGE IN $\Sigma^0K^0$ PRODUCTION. Watal, C.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., 57A: 45-8(Sept. 1, 1968).

In the reaction $\pi^- + p \to \Sigma^0 + K^0$ the angular-distribution curves for $\Sigma^0$ are plotted, taking the contribution of the $K^*$-exchange diagram and an $f_x$ resonant state in the $\Sigma^0K^0$ system. The agreement with the experimental data is reasonably good. (auth)

**46427** REGGEIZED MULTIPERIPHERAL MODEL FOR INELASTIC PROCESSES AT HIGH ENERGY. Chan, Hong-mo (CERN, Geneva); Loskiewicz, J.; Allison, W. W. M. Nuovo Cim., 57A: 93-120(Sept. 1, 1968).

By supplementing the multi-Regge model with the assumption that the structure of nonresonant low-mass clusters is governed only by phase space, a phenomenological model is constructed for production processes which allows single-particle distributions to be calculated for varying multiplicity and energy. The model is applied to analyse data from a) $\pi^-p \to p + (n-1)\pi$ and b) $K^-p \to \Lambda + (n-1)\pi$, at multiplicities n ranging from three to nine, and at energies ranging from 5 to 16 GeV/c. Good qualitative agreement with experiment is obtained for the distributions of both baryons and pions in i) cos $\theta^*$, ii) $p_T^2$, iii) $p_T$. The model is, at least in the cases examined, particularly successful in describing the interesting ways in which the distributions vary with respect to the multiplicity, the incoming energy, and the quantum numbers of the final particles. (auth)

**46428** CONSISTENCY CONDITION FOR THE INELASTIC PROCESS $\pi^- + p \to \eta + n$. Saxena, A. B.; Watal, C.; Agarwal, B. K.; Seth, V. P. (Allahabad Univ., India). Nuovo Cim., 57A: 121-4(Sept. 1, 1968).

A consistency condition was derived for the inelastic process $\pi^- + p \to \eta + n$. The nonnull condition is found to be violated when numerically tested. (auth)

**46429** BOUND-STATE THEORY OF PARTICLES: THE J = I BARYON RESONANCES. Kronfli, N. S. (Birkbeck Coll., London). Nuovo Cim., 57A: 125-39(Sept. 1, 1968).

The Lovelace-Faddeev three-particle bound-state scattering equations for a system of two pions and one baryon are used as a model where the baryons are assumed to be pion-baryon bound states. Only the case of static baryons and no $\pi\pi$ forces is considered. The equivalence of this model to another with physically dressed baryons is demonstrated. The equations are also solved exactly in a closed analytic form satisfying three-particle unitarity. As an illustration, the masses of the I = J nonstrange baryon sequence are calculated without using scattering data in a way indicating the possibility of self-consistency. The calculated ($\frac{5}{2}$, $\frac{5}{2}$) mass agrees with a possible, but still doubtful, $\pi^+\pi^+p$ enhancement. (auth)

**46430** LECTURES ON TWO-BODY REACTIONS AT HIGH ENERGIES. Byers, N. (Univ. of California, Los Angeles). pp 427-40 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

Some characteristic features of the differential cross-section data for two-body reactions at 5 to 20 GeV/c are summarized and interpreted. The interpretations are based mainly on the viewpoints of Yang and Feynman. A brief review is first given of the experimental situation regarding elastic scattering at the highest energies for the $\pi$p, Kp, pp, $\bar{p}$p interactions. The use of the eikonal approximation for analyzing two-body scattering is then discussed. Exchange scattering is discussed within the framework of the coherent droplet model by considering two examples in detail, the $\pi^-p \to \pi^0n$ and np $\to$ pn charge-exchange reactions. (L.B.S.)

**46431** SUPERCONVERGENT DISPERSION RELATION AND LOW-ENERGY KAON–PROTON INTERACTION. Liu, Yu-chien (Univ. of Rochester, N. Y.). Phys. Rev., 172: 1564-6(Aug. 25, 1968).

A simple superconvergent dispersion relation for forward $K^+p$ scattering is used to test the self-consistency of a new result obtained by Kim on low-energy $\bar{K}p$ interactions. The answer is in the affirmative, within experimental accuracy, as far as the S wave is concerned. There is an indication that Kim's value of $g_{p\Lambda K^2}$ (13.5 ± 2.4) should be lowered, while that of $g_{p\Sigma^*K^2}$ (0.26 ± 0.43) should be increased. (auth)

**46432** MODEL OF BARYONS MADE OF QUARKS WITH HIDDEN SPIN. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., 172: 1807-17(Aug. 25, 1968).

The quark model of baryons is investigated in an attempt to combine its excellent agreement with experiment with a consistent foundation. It is found that effective Bose statistics for the spin states of identical quarks (quark statistics) is sufficient to explain the properties of baryons as if the three-quark wave functions were in the 56 representation of SU(6). A new internal degree of freedom is suggested as a mechanism for achieving quark statistics with fermion quarks. This mechanism also can produce quark saturation (at 3) and allows for the possibility of light quarks ($\sim\frac{1}{3}$ $M_p$) that have a large effective mass if removed from baryons. Baryon magnetic moments and mass differences are analyzed in the quark model with the primary purpose of determining the required properties of quarks. Sum rules that are independent of quark moments in a static s-wave model are derived for baryon magnetic moments. Relativistic effects on magnetic moments are considered and are shown to be a likely mechanism for the deviation of the proton–neutron magnetic-moment ratio from the static prediction of $-\frac{3}{2}$. Higher-orbital states are also considered and a general formula is derived for orbital contributions to baryon magnetic moments. (auth)

**46433** REGGE-POLE ANALYSIS OF CHARGE-EXCHANGE AND HYPERCHARGE-EXCHANGE REACTIONS IN PSEUDOSCALAR-MESON–BARYON SCATTERING. Reeder, D. D.; Sarma, K. V. L. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 172: 1566-82(Aug. 25, 1968). (COO-881-149).

Within the context of the vector-tensor Regge-pole exchange model, the data on charge-exchange reactions ($\pi^-p \to \pi^0n$, $\pi^-p \to \eta n$, $K^-p \to \overline{K}^0n$) and hypercharge-exchange reactions [$\pi^-p \to K^0\Lambda(\Sigma^0)$, $\pi^+p \to K^+\Sigma^+$, $K^-p \to \pi^0\Lambda$, $K^-p \to \pi^-\Sigma^+$] are systematically analyzed. A statistical fit is presented which provides a good quantitative description of these data. In particular, the measured differential cross sections are adequately fitted over the momentum transfer range $0 \leq |t| \leq 2.6$ (GeV/c)$^2$. The magnitude and sign changes of the polarization data are explained by the model with the exception of the $\pi^-p \to \pi^0n$ polarization at high energies. Predictions of immediate experimental interest include (i) near-maximal polarization in $K^-p \to \overline{K}^0n$ near $t = 0$, (ii) a large polarization independent of energy for all reactions involving exchange of both a vector and tensor trajectory, (iii) differential cross sections for $K^-p \to \eta\Lambda(\Sigma^0)$, (iv) structure in differential cross sections near $t \sim -2.5$ (GeV/c)$^2$, and (v) polarization for $\pi^-p \to \pi^0n$ at intermediate energies. Assuming SU(3) symmetry for the factorized residues, the f/d ratios were determined for the vector and tensor nonet $J^P = 1/2^+$ baryon octet couplings. (auth)

**46434** COULOMB INTERFERENCE IN HIGH-ENERGY SCATTERING. West, Geoffrey B.; Yennie, D. R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 172: 1413-22(Aug. 25, 1968).

The relativistic Coulomb interference problem is carefully examined in order to evaluate critically the equations used in analyzing experiments designed to test the forward $\pi$-N dispersion relations. It is shown that with a suitable interpretation the nonrelativistic Bethe formula for the phase difference $\phi$ between the strong and electromagnetic contributions is valid. However, for high energy near forward scattering there are unknown contributions which can change this phase by $O(\alpha)$ rad; this is to be compared with a magnitude of $\phi$ of $\sim 2\alpha$ rad. It is further shown that two previous relativistic calculations of $\phi$ are incomplete. The effects of calculable radiative corrections such as soft photon emission or vacuum polarization are examined. For the former it is found that although their magnitude is relatively large, they can, in general, be neglected. The reason for this is that by folding an accurate measurement of the total cross section into the data analysis a compensation of errors is induced. No such compensation takes place for the case of vacuum polarization, and its contribution could be important. Finally, the effects of small admixtures to the strong interactions which are not of the form $e^{a+b2t}$ are investigated. It is found that they are unlikely to be of significance here provided they can be assumed to be $\lesssim 20\%$ of the complete amplitude. (auth)

**46435** OFF-MASS-SHELL APPROACH TO STRONG DECAYS OF BARYON RESONANCES. Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., 172: 1423-9(Aug. 25, 1968). (COO-1428-44).

It is shown that useful sets of self-consistency conditions on baryon resonances can be obtained from off-mass-shell dispersion relations satisfied by the decay amplitudes in which baryon resonances decay into a pion and other baryon resonances. The decay amplitudes are continued off the mass shell, not only with respect to pion in terms of divergence of axial-vector current, but also regarding baryon resonances using renormalized baryon fields. Self-consistency conditions are the off-mass-shell dispersion relations, with dispersion integrals saturated in terms of the baryon resonances which share the same quantum numbers, including spin. Use of the soft-pion technique and current-commutator algebra enables us to derive an additional set of self-consistency conditions. The details of the analysis are presented in the case of nucleon resonances with both spin and isospin 1/2. The resulting self-consistency conditions can never be satisfied unless nucleon resonances with opposite parities are both assumed. It is shown that the self-consistency conditions are consistent with all the available experiments on four nucleons. Moreover, the self-consistency conditions imply that the decay of N(1700) into N(1400) and a pion has a decay width of ~24 MeV, which can be tested by experiment. The self-consistency conditions are in favor of increasing the mass of N(1400) considerably over 1400 MeV. (auth)

**46436** DISPERSION THEORY OF LOW-ENERGY LIMITS. Fubini, S. (Massachusetts Inst. of Tech., Cambridge); Furlan, G. Contract AT(30-1)-2098. Ann. Phys. (N. Y.), 46: 322-65 (June 2, 1968).

A general technique for obtaining dispersion relations in the mass variable is proposed. The method is used in order to translate the low-energy theorems valid for "mathematical pions" of zero four-momentum into physically meaningful expressions for real pions. The procedure is explicitly applied to low-energy pion scattering and electroproduction of pions on nucleons. (auth)

**46437** DETERMINATION OF VACUUM REGGE POLES AND CUTS. Rogers, Terence W.; Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., 172: 1595-1601(Aug. 25, 1968).

The sum of the $\pi^+p$ and $\pi^-p$ forward elastic scattering amplitudes at high energies is studied from the standpoint of complex angular momentum. Experimental total cross sections and real parts, as well as the Igi sum rule, are used. It is found that excellent fits can be obtained using either two Regge poles (the P and the P′) or a pole and a cut (the P and the PP). Two-pole fits indicate that the Pomeranchukon intercept lies in the interval $0.92 \leq \alpha_P(0) \leq 1.00$. Prospects for improving these bounds with data at higher energies are investigated. (auth)

**46438** SUM-RULE CONSTRAINTS ON BARYON REGGE TRAJECTORIES. James, P. B. (Univ. of Illinois, Urbana). Phys. Rev., 172: 1602-6(Aug. 25, 1968).

The well-known MacDowell symmetry imposes conditions on the trajectory and residue functions of parity doublets of baryon Regge trajectories. A much stronger condition, degeneracy of these doublets, seems to be suggested by experiment. In order to build a consistent theory incorporating this parity degeneracy, trajectory residues must vanish at values of invariant (mass)$^2$ corresponding to unobserved states. A sum rule is derived assuming parity doubling which directly involves these zeros and which may therefore be used to check the consistency of the parity-doubling concept. A simple calculation for the $Y_1^*$ trajectory is consistent with this zero, although the approximations made would seem to make a definite conclusion impossible. (auth)

**46439** CONSEQUENCES OF A $QQ\overline{Q}$ MODEL FOR MESON–BARYON PROCESSES. Das Gupta, S.; Gupta, V. K.; Mitra, A. N. (Univ. of Delhi). Phys. Rev., 172: 1482-95(Aug. 25, 1968).

The consequences of a $QQ\overline{Q}$ model for meson–baryon processes, proposed recently by one of the authors (ANM), are examined in relation to vector-meson production in association with both the octet and the decuplet of baryons. As shown in that paper, the basic quark-meson amplitudes which represent the processes $PQ \to PQ$ and $PQ \to VQ$ (where P and V denote pseudoscalar and vector mesons, respectively) can be classified in terms of two sets $A^{(\pm)}$, where $A^{(+)}$ represents the transition amplitude between positive-parity $QQ\overline{Q}$ states, and $A^{(-)}$ between negative-parity $QQ\overline{Q}$ states. The analysis of the data, which is made most conveniently in terms of density matrices for spin-1 and spin-3/2 final-state objects, shows that several of the experimental density matrices can be fitted in terms of either of the sets $A^{(+)}$ and $A^{(-)}$, though a dominance of $A^{(-)}$ seems to be favored by experiment. However, density matrices for certain processes like $PB \to VB$ are found to require both $A^{(+)}$ and $A^{(-)}$ for a proper fit to the experimental data. A sum rule of the form $\frac{1}{3}[\rho^D_{3,3} + \sqrt{3}\rho^D_{3,-1}] = \rho^V_{1,1} + \rho_{1,-1}$, which is derived for the density matrices using both the amplitudes $A^{(\pm)}$, is found to be identical with one obtained by other authors using the additivity assumption, thus extending the range of validity of this result beyond pure additivity. Using only $A^{(-)}$ amplitudes, certain results on the angular distribution of the density matrices for $PB \to VB^*$ processes, especially their zero-angle behavior, are found to agree rather well with experiment, the agreement being somewhat better than for $SU(6)_w$. From the experimental point of view, the $QQ\overline{Q}$ model also seems to work somewhat better than the additivity principle in respect of density matrices like $\rho_{1,0}$, inasmuch as this model predicts them to be nonzero in nonforward directions, while the additivity assumption makes them identically zero for all angles. The main conclusions of this investigation are as follows: (1) Experiment is consistent with the dynamical assumption of dominance of the $Q\overline{Q}$ force over the $QQ$ force, which implies a higher priority for multiple-scattering effects within the $QQ\overline{Q}$ system than for the scattering of the meson by the quark constituents of the baryon. (2) Experiment is also consistent with the SU(3) and spin independence of the quark forces. (3) While the precise mechanism of the quark forces cannot be studied in this model, it nevertheless suggests a general classification of the meson amplitudes in terms of two distinct types $A^{(+)}$ and $A^{(-)}$ of which the latter is favored most by experiment. (auth)

**46440** ELECTROMAGNETIC PERTURBATIONS ON $\pi$NN AND $\pi$NN* COUPLINGS IN THE CHEW-LOW MODEL: DETAILED CALCULATION. Thornber, N. S. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 172: 1395-1401(Aug. 25, 1968). (CALT-68-151).

Electromagnetic perturbations on $\pi$NN and $\pi$NN* couplings are studied in the N-N* reciprocal bootstrap model. Explicit calculations are performed for both linear and curved D functions. The linear-D results agree with the conclusions reached in the previous paper. No enhancement of eigenvectors with eigenvalue equal to (or near to) +1 occurs, and thus the results are not accurate numerically. It is not expected, however, that the prediction of very small effects ($\delta R/R \cong 1\%$) is reliable. (auth)

**46441** ELECTROMAGNETIC PERTURBATIONS ON $\pi$NN AND $\pi$NN* COUPLINGS IN THE CHEW-LOW MODEL: GENERAL FEATURES. Babu, P.; Frautschi, S.; Thornber, N. S. (Cali-

fornia Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 172: 1389-94(Aug. 25, 1968). (CALT-68-150).

Electromagnetic perturbations on $\pi NN$ and $\pi NN^*$ couplings are studied in the N-N* reciprocal bootstrap model. Consideration is given only to rather general features, making the linear-D approximation for simplicity. There are several self-consistent coupling shifts, much as in the analogous SU(3) reciprocal bootstrap. It is shown that, except for even-J exchanges in the t channel, the "driving terms" are orthogonal to these self-consistent coupling shifts. Thus, as in the SU(3) case, no simple predictions can be made for coupling shifts in the linear-D approximation. (auth)

**46442** BOOTSTRAP CALCULATION OF VECTOR-MESON–BARYON COUPLING CONSTANTS. Kane, G. L. (Univ. of Michigan, Ann Arbor); Palmer, W. F. Phys. Rev., 172: 1648-63(Aug. 25, 1968).

A bootstrap calculation designed to study the vector-meson–baryon coupling constants is performed. The vector mesons appear as baryon-antibaryon bound states, due to vector- and pseudoscalar-meson exchanges, so that the self-consistency between the couplings at the exchanges and the couplings that emerge at the residues allows the $VB\bar{B}$ coupling constants (including d/f ratios) to be calculated. The problem is studied both in the static model [no SU(3) self-consistent solutions exist] and in the relativistic case with pseudoscalar-meson exchange contributing an inhomogeneous driving term, where approximately self-consistent solutions do exist. (auth)

**46443** REACTION AMPLITUDES FOR PSEUDOSCALAR MESONS ON SPIN-$\frac{1}{2}$ FERMIONS IN FOURTH-ORDER PERTURBATION THEORY. Kubis, Joseph J. (Texas A and M Univ., College Station. Cambridge Univ., Eng.); Gammel, John L. Phys. Rev., 172: 1664-74(Aug. 25, 1968).

The invariant reaction amplitudes for pseudoscalar mesons on spin-$\frac{1}{2}$ fermions are calculated in fourth-order perturbation theory. The masses of the incoming, outgoing, and internal lines of all the diagrams are arbitrary, subject to some tacit restrictions about anomalous thresholds. The amplitudes for the self-energy, vertex, and box graphs are calculated by dispersion-relation techniques. Formulas for absorptive parts and double spectral functions are explicitly given, and the self-energy and vertex graphs have been renormalized. The A amplitude for the box diagram is expressed as a single-variable dispersion relation plus a once-subtracted double dispersion relation. Numerical as well as analytic methods were used to check the expressions obtained. (auth)

**46444** SOME ASPECTS OF THREE-PARTICLE SCATTERING. DeSanto, John Anthony. Ann Arbor, Mich., Univ. of Michigan, 1967. 74p.

Thesis.

Various aspects of three-particle scattering phenomena and the question of whether a resonance can itself serve as a resonance generating mechanism are considered. Three particles, two pions and a nucleon, scattering through bound states of one pion and the nucleon are considered. There are two bound pion-nucleon states corresponding to the nucleon itself and the N* (1236) resonance. The coupled channel problem is investigated using off-energy-shell techniques. The problem is solved by initially considering the N* to be stable and then analytically continuing to the unstable particle parameters. The resulting analytic properties of the scattering amplitudes and the conditions under which we can generate a resonance are discussed. The connection of this work with Lee model calculations involving an unstable $\nu$ particle are pointed out. The usefulness of the off-energy-shell techniques is briefly discussed. (Diss. Abstr.)

**46445** HIGH-ENERGY HADRON SCATTERING. le Bellac, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 275-95 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

The scattering of two hadrons A and B, with initial four-momenta k' and p' is considered. Asymptotic theorems are discussed, and potential scattering, that is, scattering by a superposition of Yukawa potentials with some technical restrictions is treated. Finally, the Regge phenomenology of high energy meson–baryon scattering is discussed. (J.F.P.)

**46446** RADIATIVE MESON DECAYS IN BROKEN SU(3). Brown, Laurie M.; Munczek, Herman; Singer, Paul (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett., 21: 707-11 (Sept. 2, 1968).

Vector and pseudoscalar meson decays are considered using vector gauge fields with current mixing. The processes $\omega \to 3\pi$, $\omega \to \pi\gamma$, and $\pi \to 2\gamma$ are fitted with one value of the gauge field's coupling g, which also determines leptonic decay rates of vector mesons. Octet breaking of the underlying VVP strong interaction introduces four parameters. The available experimental information on $\pi$, $\eta$, $\omega$, and $\varphi$ decays gives relations among these parameters which predict rates for decays such as $K^* \to K\gamma$. (auth)

**46447** REGGE STRUCTURE OF THE $B^{(-)}$ AMPLITUDE IN $\pi N$ SCATTERING. Aviv, R.; Horn, D. (Tel-Aviv Univ., Israel). Phys. Rev. Lett., 21: 704-7(Sept. 2, 1968).

Applying the technique of finite-energy sum rules to the recent CERN $\pi N$ phase-shift analysis, the Regge structure of $B^{(-)}$ at large momentum transfer is investigated. The features found are most easily explained by an additional fixed pole at $\alpha = -1$. Some of its implications are discussed. (auth)

**46448** ELASTIC SCATTERING OF VECTOR MESONS BY PROTONS FROM PHOTOPRODUCTION. Margolis, B. (CERN, Geneva). Nucl. Phys., B6: 687-92(1968).

Using the vector dominance model the momentum transfer dependence of the scattering of vector mesons by nucleons is inferred from photoproduction data. It is shown that this scattering agrees with that deduced from a broken $SU_3$ quark model. The small slope of $\varphi$ photoproduction at incident momenta of a few GeV/c is accounted for. The analysis indicates a size for the $\rho^0$ meson similar to that of the pion. (auth)

**46449** MESON-NUCLEUS INTERACTIONS AT VERY HIGH ENERGIES. Artykov, I. Z.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B6: 628-32(1968).

Inelastic interactions of $\pi$-mesons with the emulsion nuclei at an average energy of 200 GeV are considered from the point of view of the intranuclear cascade model. It is taken into account that several fast particles can interact simultaneously with one intranuclear nucleon. The number of such many-particle interactions is more than one-third the total number of elastic and inelastic collisions of fast particles inside the nucleus. The results of calculations agree well with experiment. (auth)

**46450** FACTORIZATION OF REGGE AMPLITUDE AND SUPERCONVERGENCE. Seth, V. P.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., 56A: 1122-4(Aug. 21, 1968).

The Regge asymptotic behavior of the amplitudes for $\pi$ + N and K + N elastic scattering is studied. A superconvergence sum rule is obtained and verified. (L.B.S.)

**46451** FINITE-ENERGY SUM RULES AND $\rho$NN COUPLINGS. Amann, R. F. (International Atomic Energy Agency, Trieste, Italy. International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 56A: 1125-8(Aug. 21, 1968).

It is shown that plausible assumptions on the behavior of fermion Regge poles lead, via finite-energy sum rules, to effective superconvergence relations for the $\pi$N amplitudes at fixed u = 0. The sum rules are consistent with each other but in disagreement with the normal values of the $\rho$NN coupling when just the $\rho$-meson is used for the t-channel saturation. New values of the $\rho$NN couplings are suggested, and they are found to saturate these sum rules, as well as to improve the experimental success of the $\rho$-dominance model. (L.B.S.)

**46452** SCATTERING LENGTHS IN THE MULTICHANNEL CASE BY CURRENT-ALGEBRA TECHNIQUES. Gundzik, M. G. (Argonne National Lab., Ill. Univ. of Washington, Seattle). Nuovo Cim., 56A: 1075-86(Aug. 21, 1968).

The calculation of S-wave scattering lengths in the multichannel case by current-algebra techniques is considered with the inclusion of unitarity corrections. As an example of the formalism the $\pi\Sigma$ scattering lengths are calculated in the case of nondegenerate $\Lambda$ and $\Sigma$ masses. It is found that the I = 1, $\pi\Sigma$ S-wave scattering length is given by $a_1 + ib_1 = 0.22 + i0.0$ in agreement with recent partial-wave analysis of $\bar{K}N$ data. The formalism is also used to investigate the consistency of the $\pi\Sigma$ scattering lengths with a $\pi\Sigma$ forward dispersion relation. It is found that if the $\pi\Sigma \to \pi\Lambda$ amplitude at the $\pi\Sigma$ threshold is left as a free parameter and the dispersion integral is approximated by S-waves and resonances, then a large value which contradicts the $\bar{K}N$ data is required for consistency. This suggests that in this case such an approximation of the dispersion integral is inadequate. (auth)

**46453** ASYMMETRIC FERMION TRAJECTORIES AND MODELS FOR BACKWARD ASSOCIATED PRODUCTION IN $\pi^- p \to \Lambda K^0$. Hoegaasen, H. (Institut de Physique Nucleaire, Paris). Nuovo Cim., 56A: 915-21(Aug. 21, 1968).

The backward $\Lambda$ production in $\pi^- p \to \Lambda K^0$ is analyzed in terms of Regge fermion exchange. It is argued that the effects of this exchange will also lead to important polarization effects in very-high-energy reactions giving three-particle final states. A motivated guess for the polarization in $\pi^- p \to p\pi^-$ is given. (auth)

**46454** LOW-ENERGY THEOREM FOR PIONS. Martinis, M. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 56A: 933-51(Aug. 21, 1968).

Under the assumption that incoming and outgoing pions have zero mass a gauge principle for the S-matrix is developed, leading to the generalized Adler self-consistency condition that all pion amplitudes vanish at zero pion four-momentum. In the second part the theory of composite particles is discussed from a more fundamental point of view, in connection with $\rho$-meson and low-energy $\pi$N-scattering. A result equivalent to that of Adler and Weisberger is derived and comparison with other models discussed. The generalization to forward scattering of low-energy zero-mass pions off any target is also indicated. (auth)

**46455** VALIDITY OF THE INTERFERENCE MODEL FOR $\pi$N SCATTERING. Chiu, C. B. (CERN, Geneva); Stirling, A. V. Nuovo Cim., 56A: 805-37(Aug. 21, 1968).

It is shown in an extensive analysis of the $\pi$N scattering data between 2 and 6 GeV/c that the interference model does not account correctly for some features of the data. Therefore some modifications of the model would be needed, if it is further applied to analyze all the forward and backward data in the intermediate energy region. (auth)

**46456** NEW SCHEME FOR THE CLASSIFICATION OF BARYON RESONANCES. Mitra, A. N. (CERN, Geneva). Nuovo Cim., 56A: 1164-7(Aug. 21, 1968).

The Dalitz quark-model analysis of resonances within the framework of harmonic oscillator wave functions is discussed, and its shortcomings are pointed out. An alternative scheme is suggested, which brings out precisely the $SU_6 \times O_3$ states required in the Dalitz analysis and eliminates the unwanted harmonic oscillator states on dynamical grounds. (L.B.S.)

**46457** OBSERVATION OF THE RARE DECAY MODE OF THE $\varphi$-MESON: $\varphi \rightarrow e^+e^-$. Bollini, D.; Buhler-Broglin, A.; Dalpiaz, P.; Massam, T.; Navach, F.; Navarria, F. L.; Schneegans, M. A.; Zichichi, A. (CERN, Geneva. Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna. Centre de Recherches Nucleaires, Strasbourg). Nuovo Cim., 56A: 1173-84(Aug. 21, 1968).

The results of an experiment designed to detect the decay mode $\varphi \rightarrow e^+ + e^-$ are reported. The $\varphi$-mesons were produced by 1.93 GeV-pions incident on a liquid-hydrogen target according to the reaction $\pi^- + p \rightarrow n + \varphi$. Details are given of the experimental set up and the electronic logic. The cross section, decay width, and branching ratio are determined. (L.B.S.)

**46458** SPLITTING OF THE CROSS SECTION INTO NATURAL AND UNNATURAL PARITY EXCHANGE CONTRIBUTIONS FOR QUASI-TWO-BODY REACTIONS. Ader, J. P. (Laboratoire de Physique Theorique, Bordeaux); Capdeville, M.; Cohen-Tannoudji, G.; Salin, Ph. Nuovo Cim., 56A: 952-66(Aug. 21, 1968).

It is shown that in quasi-two-body reactions $1 + 2 \rightarrow 3 + 4$ it is possible to split the experimental cross sections in parts with only natural or unnatural parity exchange, and this for each helicity state of the particles. When one of the initial particles is spinless, the result is readily obtained by looking at very simple linear combinations of the usual measured density-matrix elements. When none of the initial particles are spinless one has to perform a single well-defined polarization experiment. It is also shown that it is experimentally possible to distinguish a Reggepole model with evasive and/or conspiring trajectories, from other possibilities. (auth)

## *Strong (Baryon No. ≥ 2)*

*Refer also to abstracts 46389 and 46543.*

**46459** (ORNL-TM-2277) ANALYTIC REPRESENTATION OF NUCLEON- AND PION-EMISSION SPECTRA FROM NUCLEON-NUCLEUS COLLISIONS IN THE ENERGY RANGE 750 TO 2000 MeV. Alsmiller, R. G. Jr.; Barish, J. (Oak Ridge National Lab., Tenn.). July 1, 1968. Contract W-7405-eng-26. 77p. Dep. CFSTI.

Analytic fits, obtained by the method of linear least squares, to the intranuclear-cascade data generated by H. W. Bertini are given. For 750-, 1000-, and 2000-MeV protons incident on oxygen, aluminum, and lead, and for 1000-MeV neutrons incident on these same elements, analytic expressions are given for the cascade neutron-, proton-, $\pi^+$-, $\pi^0$-, and $\pi^-$-emission spectra in the laboratory angular intervals 0 to 30, 30 to 60, 60 to 90, 90 to 180, and 0 to 180°, and the evaporation neutron- and proton-emission spectra. (auth)

**46460** INVESTIGATION OF FOUR-DIMENSIONAL MOMENTA TRANSMITTED IN HIGH-ENERGY INTERACTIONS BETWEEN COSMIC-RAY PARTICLES. Eremenko, Yu. A.; Lukin, Yu. T.; San'ko, L. A.; Takibaev, Zh. S.; Usik, P. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 365-7(Mar. 1968). (In Russian).

A method of explaining the dynamics of inelastic interactions is based on plotting the square of the four-momenta $k_n^2$ as a function of the number of particles n. In the case of cosmic ray particle interactions there is no information on the nature and momenta of secondary particles, but qualitative differences between events can be detected by comparing Feynman diagrams with plots of $k_n^2$ versus n. Thus a momentum transfer of $<1$ (GeV/c)$^2$ corresponds to a peripheral interaction of nucleons. The formation of two fireballs can be assumed if one of the intermediate values of $k_n^2 < 1$ (GeV/c)$^2$. The central interaction is indicated by values of $k_n^2 > 1$. A total of 180 nucleon–nucleon interactions with $n > 6$ at energies of $10^{11}$ to $10^{13}$ eV, and of 84 cosmic ray particle interactions with carbon atoms were analyzed by this method. More than 80% of the events were peripheral interactions. The fraction of events having two fireballs increased with increasing primary energy. No events involving a central interaction were observed. A theoretical curve calculated from a model of single-pion exchange with the exponential form factor for the nucleon peak being taken into account satisfactorily described the results. (TTT)

**46461** MODEL OF HIGH-ENERGY NUCLEON INTERACTIONS WITH NUCLEI FORMING TWO-MAXIMUM JETS. Gerasimova, N. M. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 354-6(Mar. 1968). (In Russian).

During the interaction of a high-energy nucleon with a nucleus, the resulting particles frequently have an angular distribution with two maxima. The data always show more particles over the narrow solid angle than over the wider (diffused) solid angle. The following model is assumed to explain the events with double maxima. The incident nucleon interacts peripherally with one of the nucleons of the nucleus. Two fireballs are formed with energy KE. Here E is the primary energy of each nucleon in this system, and K is the coefficient of inelasticity. The fireballs move with a velocity $\beta$ in this system. The fast fireball moves in the direction of the primary nucleon, and the slow one moves in the opposite direction. The fast fireball is active, and can capture another nucleon of a nucleus in its path. The slow fireball can decay to separate $\pi$-mesons. With the absence of any secondary reactions in the diffuse region, it is shown that the number of particles at a narrow solid angle is always greater than the number of particles over the wider solid angle. (TTT)

**46462** PROTON–NUCLEUS SCATTERING AT VERY HIGH ENERGY. Kanada, Hiroyuki; Sakai, Kenji; Yasuno, Masaru (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 39: 1599-1601(June 1968).

Differential cross sections for proton elastic scattering and quasi-elastic scattering at 1 and 21 GeV are studied within the framework of the composite model. Calculated results for p-$^{12}$C scattering are compared with experimental data. (L.B.S.)

**46463** MONTE CARLO CALCULATIONS OF THE NUCLEON–MESON CASCADE IN IRON INITIATED BY 1- AND 3-GeV PROTONS AND COMPARISON WITH EXPERIMENT. Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 33: 291-6(1968).

Results from Monte Carlo calculations of the longitudinal and lateral development of the nucleon-meson cascade in iron initialed by 1- and 3-GeV protons are presented and compared with experimental results. In general, the calculated and experimental results are in good agreement, although in the 3-GeV case the calculation yields a smaller buildup of particles for the smaller penetration depths. The Monte Carlo results for the longitudinal development are also compared with available results from a calculation using the straightahead approximation, and the agreement is quite good. (auth)

**46464** DIFFRACTION–DISASSOCIATION MODEL OF VERY-HIGH-ENERGY NUCLEON–NUCLEON INTERACTIONS AND THE DIFFUSION OF COSMIC RAYS THROUGH THE ATMOSPHERE. Adair, Robert K. (Brookhaven National Lab., Upton, N. Y. Yale Univ., New Haven). Phys. Rev., 172: 1370-80(Aug. 25, 1968).

A simple model of very-high-energy nucleon–nucleon interactions is constructed on the assumption that at sufficiently high energies the dominant processes can be described in terms of the production of two centers—fireballs—which carry the same quantum numbers (except angular momentum) as the corresponding nucleons, and that the cross section for producing fireballs of a definite invariant mass will decrease with energy at the same rate as the elastic scattering cross section. The rate of decrease is assumed to be derived from the dominance of the exchange of a Pomeranchuk Regge trajectory. Fireball mass spectra are defined by the model without the introduction of arbitrary parameters. Meson production multiplicities and nucleon inelasticity factors, which are derived from the fireball mass distributions with minimal additional assumptions, are in accord with experi-

mental observations of nucleon–nucleon interactions. This description of nucleon–nucleon interactions is then used to construct a model of the propagation of cosmic rays through the atmosphere. The nucleon attenuation lengths, the muon energy spectra, and the muon charge ratios deduced from the model are in qualitative agreement with observations. (auth)

**46465** PARAQUARKS, STRUCTURAL SATURATION, AND HARD CORE. Mitra, A. N. (Univ. of Delhi. Univ. of California, Los Angeles); Moszkowski, S. A. Phys. Rev., 172: 1474-81 (Aug. 25, 1968).

This investigation, which is concerned with the effect of parastatistics for more than one baryon, has a twofold objective, viz., to show that (i) saturation of baryon energy levels and (ii) short-range repulsion between baryons can both be thought of as consequences of parastatistics symmetry in a multiquark system. An explicit method of construction of the multiquark wave functions of appropriate symmetry is outlined. The saturation of baryon energy levels is also found to depend crucially on a relation of the form $V_s = -2V_a$, where $V_s$ and $V_a$ are, respectively, the even and odd parts of the quark–quark potential. The problem of short-range repulsion is investigated with the help of a two-quark model of baryons, via a four-particle nonrelativistic Schrödinger equation for a [2,2] symmetric wave function characteristic of parastatistics symmetry. An explicit solution for the baryon–baryon amplitude is obtained with the help of a factorable, s-wave interaction between the quarks and brings out clearly the effect of structural repulsion. (auth)

**46466** HIGH-ENERGY PROTON–PROTON SCATTERING AND NUCLEON STRUCTURE: THE SCALAR INTERACTION IN O (4,2). Barut, A. O.; Corrigan, Dennis (Univ. of Colorado, Boulder). Phys. Rev., 172: 1593-5(Aug. 25, 1968).

A formula is derived from the simple scalar interaction in the relativistic O(4,2) model of the baryons that accounts for the high-energy proton–proton scattering at fixed angle over a cross-section range of eight decades, with a single over-all constant as the parameter. The theory also explains why there is an apparent relation between the nucleon–nucleon scattering and the electromagnetic form factors. Further implications and developments of the theory are discussed. (auth)

**46467** TWO-PION-EXCHANGE THEORY. NUCLEON–NUCLEON SCATTERING. Yock, P. C. M. (Univ. of Auckland, New Zealand). Phys. Rev., 172: 1844-9(Aug. 25, 1968).

Two-pion-exchange contributions to NN and $\bar{N}N$ scattering at around 2.6 BeV/c are calculated. It is found that the two-pion-exchange mechanism accounts for roughly half of each of the absorptive forward elastic amplitudes, and that the imaginary part of the forward amplitude for the charge-exchange process $np \to pn$ can be attributed entirely to two-pion exchange. The method of calculation entails a spinless approximation, the purpose of which is to clarify the physical analysis at the expense of little loss of numerical accuracy. As a byproduct of this method, the distorted-wave one-pion-exchange prediction for the reaction $\pi N \to f^0N^*(1238)$ is very simply verified. (auth)

**46468** LARGE-ANGLE SCATTERING AND THE FIFTH INTERACTION. Ne'eman, Y. (Tel-Aviv Univ., Israel). Phys. Rev., 172: 1818-21(Aug. 25, 1968).

It is suggested that the recent fit by Abarbanel et al. of $d\sigma/dt$ for p-p elastic scattering at large s and t to a curve of the electromagnetic form factor raised to fourth power, $[G_{M_p}(t)]^4$, corresponds to the SU(3)-breaking interaction. This is the only non-Regge pole in the strong interaction, which is otherwise entirely described by Regge-trajectory or bootstrap dynamics. (auth)

**46469** ZERO-PARAMETER MODEL OF THE N–N POTENTIAL. Sugawara, Hirotaka (Univ. of California, Berkeley); von Hippel, Frank. Phys. Rev., 172: 1764-88(Aug. 25, 1968).

A theoretical N-N potential is presented containing, in addition to the one-pion-exchange contribution, vector-meson-exchange terms and contributions due to the inelastic interactions $N + N \to N + \Delta(1236)$ and $N + N \to \Delta(1236) + \Delta(1236)$. There are no adjustable parameters in this calculation, which otherwise, however, suffers from most of the usual shortcomings and difficulties of few-particle-exchange models for strong-interaction processes. The vector-meson coupling constants are fixed by electromagnetic form factors and backward vector-meson production data, while the phenomenological constants in the inelastic contributions to the potentials have been fixed by the experimental data on the inelastic reactions themselves. The results are found to be in qualitative agreement with phenomenological potentials obtained by Reid from the N-N scattering data. The vector-meson-exchange potentials are also calculated for all B-B and B-$\bar{B}$ states with $J \leq 2$. The results indicate that the B-B interaction will contain a short-range repulsion in all states of practical interest aside from the $T = 1$ $\Xi$-N state which is discussed. Strong attractions are found in most of the SU(3) singlet and octet B-$\bar{B}$ states. (auth)

**46470** THRESHOLD PION PRODUCTION IN NUCLEON–NUCLEON COLLISIONS. Schillaci, M. E.; Silbar, R. R.; Young, J. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 21: 711-14(Sept. 2, 1968).

Results pertaining to threshold $\pi$ production in nucleon-nucleon collisions, obtained in the soft-pion approximation are presented. A typical result is $\sigma_{tot}(pp \to np\pi^+) = 24\ \mu b$ at $T_{lab} = 310$ MeV, in good agreement with extrapolations from higher energy data. (auth)

**46471** CONNECTION BETWEEN PHENOMENOLOGICAL FITS FOR HIGH-ENERGY DATA. Fleming, H.; Giovannini, A.; Predazzi, E. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim., 56A: 1131-4(Aug. 21, 1968).

The three-Gaussian formula used by Krisch (Phys. Rev. Lett., 19: 1149(1967)) for fitting the high-energy p-p elastic scattering data over the entire angular interval is replaced by an infinite series of Gaussians such that the first few terms reproduce Krisch's formula. This leads to a four-parameter integral formula which provides a good fit to the experimental data. (L.B.S.)

**46472** LARGE-ANGLE SCATTERING AND THE PION'S REGGE TRAJECTORY. Freund, P. G. O. (Univ. of Chicago). Contract AT(11-1)-264. Nuovo Cim., 56A: 1087-93(Aug. 21, 1968). (COO-264-417).

It is pointed out that in high-energy pp-scattering at large momentum transfers $(-t \gtrsim 6\ (\text{GeV})^2)$ the Pomeranchukon contribution may be small and the pion trajectory may take over. The argument is centered around a lower bound for scattering amplitudes and the idea of exchange degeneracy. The kinematical variable $x = -t \ln((3 + \cos\theta)/(1 - \cos\theta))$ is provided naturally by this picture for the discussion of large-angle pp-scattering data. (auth)

**46473** DISPERSIVE IMPULSE APPROXIMATION AND NUCLEON–DEUTERON ELASTIC SCATTERING. Chahoud, J. N. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna); Russo, G.; Mazzanti, P.; Salvini, M. Nuovo Cim., 56A: 838-66 (Aug. 21, 1968).

A complete calculation is presented of the nucleon-deuteron elastic scattering in the GeV region in the framework of the first-order dispersive impulse approximation. This model is based on the evaluation of the single-scattering term calculated by dispersive theoretical techniques. Moreover the dispersive integrals are limited to the lowest, and therefore nearest singularity. No free parameter enters in the model. The absolute value of the cross section thus obtained is in good agreement with experiments. Furthermore the relevant features of the experimental cm angular distribution, i.e., a high and narrow peak in the forward direction and a very broad peak in the backward one are well reproduced. (auth)

# Particle Invariance Principles and Symmetries

## General

*Refer also to abstracts 46499, 46795, 46797, 46837, 46854, and 46846.*

**46474** GROUP DYNAMICS OF ELEMENTARY PARTICLES. Kleinert, Hagen M. (Univ. of Colorado, Boulder). Fortschr. Phys., 16: 1-74(1968).

It is proposed that particle interactions can be described by means of simple group operations in noncompact Lie groups. Prescriptions for the structure of these group operations are formulated which are motivated by the study of simple models, in particular of the dynamics of the hydrogen atom. If they are fulfilled the structure is called "group dynamics." Neglecting at first internal symmetries, a few simple models are investigated in which group dynamics is possible. The group O(3,1) turns out to describe the coupling of pseudoscalar mesons, O(4,2) that of photons to baryons quite well: The pionic decay rates of baryon resonances up to spin 19/2 and the electromagnetic form factors of the nucleons are predicted in good agreement with experiment. The internal symmetry SU(3) is included in the O(3,1) model of the pionic coupling in the simplest way, by assuming $O(3,1) \times SU(3)$ to be the dynamical group. This gives rise to a minimal symmetry breaking of the amplitudes and relates it to the mass differences in SU(3) multiplets: The amplitude consists of a product of a SU(3) Clebsch Gordan coefficient and a universal function of the velocity of the final baryon. The way the particle masses enter the decay rates is uniquely prescribed in this approach. The agreement with

experiment is excellent. Finally, the connection of this purely algebraic approach with related ideas, like the use of infinite component wave equations, is discussed. (auth)

**46475** CLASSICAL SYMMETRIES: AN ELEMENTARY SURVEY. Lopes, J. Leite. pp 171-244 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

An elementary review is given of the invariance properties of the laws of the classical mechanics of systems of point-particles (sect. 1); it is well-known that the conservation laws in this theory are not deducible from the invariance principles and Newton's equations of motion but, rather, from these principles and Lagrange's equations. The extension of the Lagrangian formalism to classical linear field theories is recalled, and the famous theorem of E. Noether, which provides a rule for the construction of conserved physical variables corresponding to invariance principles, is established (sect. 2). Finally, the foundations of Einstein's relativistic theory of gravitation are sketchily presented with the intention of showing that it is not possible to associate an energy-momentum tensor — but only a coordinate-dependent object or pseudotensor — to the gravitational field (sect. 3). (auth)

**46476** "INVARIANCE" AND "NON-INVARIANCE" DYNAMICAL GROUPS. Vitale, B. (Univ., Naples). pp 349-88 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

The effects of dynamical symmetries in classical and quantum systems are treated, using non-relativistic models in two dimensions. More realistic problems in three dimensions are then treated, discussing in detail the cases of the harmonic oscillator, the hydrogen atom, and the rigid rotator. It is then shown, by using the hydrogen atom as a model, how the definition of the symmetry group can help in solving a dynamical problem and lead to the energy spectrum and degeneracy of a system. The discussion is concluded with an analysis of some significant examples of non-invariance dynamical symmetries. (L.B.S.)

**46477** MASS RELATIONS FOR PARTICLES OF ARBITRARY SPIN. Voelkel, A. H. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Ann. Phys. (N. Y.), 48: 265-91(June 2, 1968).

The equal-time-limit of matrix elements of current commutators is calculated in a one-particle approximation, which does neither destroy locality nor current conservation. The result is applied to derive SU(3) mass relations for particles of arbitrary spin. For particles with spin S = 0 and S = ½, the usual (quadratic respectively, linear) relations are reproduced. For higher spins the relations become more complicated and the order in the masses increases with increasing spin values. For spin one octets the Gell-Mann–Okubo relation is obtained with the masses occurring in fourth order. (auth)

**46478** SIMPLIFIED DERIVATION OF THE IRREDUCIBLE REPRESENTATIONS OF SU(3). Nelson, T. J. (Ames Lab., Iowa). Amer. J. Phys., 791-9(Sept. 1968).

A simple solution to the eigenvalue problem posed by a set of operators which have the commutation rules of SU(3) is developed. The analogy with the more familiar problem for SU(2), i.e., angular momentum, is used as a guide. The set of labels used to describe the states in an irreducible representation admits of a folded-ladder interpretation that is particularly transparent. Finally the dimensionality formula and the effect of complex conjugation are derived. (auth)

**46479** SPECTRAL REPRESENTATIONS FOR SYMMETRY-BREAKING PARAMETERS. Perrin, Robert (Harvard Univ., Cambridge, Mass.). Phys. Rev., 172: 1675-7(Aug. 25, 1968).

Spectral representations are obtained for the SU(3) and chiral symmetry-breaking parameters. Some relations among integrals of scalar and pseudoscalar spectral functions are also obtained. (auth)

**46480** INTERNAL SYMMETRIES IN S-MATRIX THEORY. Coon, Darryl Douglas. Princeton, N. J., Princeton Univ., 1967. 125p.

Thesis.

A rigorous abstract treatment of internal symmetry in S-matrix theory is reviewed, developed and applied to particular cases. It is shown that all the consequences of internal symmetry, including kinematic identity of the channels involved, follow from a simple criterion by rigorous application of unitarity and crossing. Among the symmetries which are found in the scattering of the eight pseudoscalar mesons ($\pi$,K,$\eta$) with various conditions on the masses are isotopic spin, $G_2$, $C_2$, $SU_2$ (quark) × $SU_2$ (anti-quark) and $SU_3$. Some other solutions have not been identified with a symmetry group. Accepting $SU_3$ in the pseudoscalar-baryon system and postulating further symmetry, the Barger–Rubin and Johnson–Treiman relations are found among the solutions. Also, a definite, finite prediction for f/d is obtained. General formulas are derived for f/d and determinations of f/d are obtained from cross section data. A criticism of the usual approximate dynamical schemes which claim to derive internal symmetries is included. (Diss. Abstr.)

**46481** DERIVATION OF THE MAJORANA EQUATION FROM IRREDUCIBLE POINCARE REPRESENTATIONS. Calucci, G.; Ghirardi, G. C. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim., 56A: 1113-16 (Aug. 21, 1968).

The explicit construction of manifestly covariant wave functions and equations from the wave functions transforming according to the irreducible unitary representations of the restricted Poincare group is performed for the Majorana equation. (L.B.S.)

## *Applications (Electromagnetic and Weak)*

**46482** (LPTHE-TH-68/12) THE SUPERWEAK MODEL OF PC VIOLATION. Gourdin, M. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Mar. 1968. 20p. (In French). (CONF-680318-1). Dep.

From Conference on Electromagnetic Interactions, Lac-de-Tignes, France.

The superweak theory of PC violation, proposed by Wolfenstein, is presented in a more systematic fashion and freer from contingencies due to discrete symmetries. The results obtained are compared with experimental data. (J.S.R.)

**46483** NONLEPTONIC HYPERON DECAYS AND THE U(4) MODEL. Koide, Yoshio (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 39: 1598-9(June 1968).

The nonleptonic hyperon decays are discussed on the basis of the two-body interaction of urbaryons and U(4) symmetry. Relations among S-wave and P-wave decay amplitudes are obtained, which are in good agreement with experiment. (L.B.S.)

**46484** SPACE AND TIME ASYMMETRIES IN PARTICLE PHYSICS. Poirier, C. P. Res. Rev. (Office Aerosp. Res.), 7: No. 4, 22-3(Apr. 1968).

The violation of space–time symmetries in K decays is reviewed. Evidence for this violation is given, and four classes of theories for explaining the origin of the CP violation are summarized. Some implications of this space–time symmetry are given. (J.F.P.)

**46485** SPECTRAL-FUNCTION SUM RULES AND THE RATIO $f_K/f_\pi$. Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan); Fayyazuddin. Phys. Rev., 172: 1737-9(Aug. 25, 1968).

A new sum rule for spectral functions which enter into the propagators of the pseudoscalar-meson octet or nonet is derived as a low-energy theorem. This sum rule, when combined with Weinberg's first sum rule, leads to a determination of the ratio $f_K/f_\pi$ for the coupling constants which enter into the two-body leptonic decays of $\pi$ and K mesons in terms of the masses of the pseudoscalar nonet and the mixing angle between the I = Y = 0 members of the unitary octet and singlet. Numerical estimates for the ratio $f_K/f_\pi$ are given and discussed. (auth)

**46486** BROKEN SU(3) SYMMETRY, SUM RULES, AND THE MAGNETIC MOMENTS OF THE BARYONS. Cheng, T. P.; Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev., 172: 1635-45(Aug. 25, 1968).

Motivated by the increasing accuracy with which the magnetic moments of strange baryons are being measured, a calculation of these moments in broken SU(3) symmetry is presented without appeal to a highly detailed theory of symmetry breaking. As primary ingredients in the calculation, only the SU(2) transformation properties of the electromagnetic current, the octet transformation property of the symmetry-breaking medium-strong interaction, and the validity of the Drell-Hearn-Gerasimov sum rule for the anomalous moments are assumed. Saturating this sum rule with the dominant states, the decuplet and a singlet, but making no SU(3) assumptions on the couplings of these states or their masses, it is found that all eight baryon anomalous magnetic moments and the $\Sigma^0\Lambda$ transition moment can be expressed in terms of $\kappa_p$, $\kappa_\Lambda$, and $\kappa_{\Sigma^+}$ through relations that are valid in broken symmetry with an expected accuracy of about 10%. Further assuming the absence of the 27 in the current, it is found that $\kappa_{\Sigma^+} = \kappa_p - 4\kappa_\Lambda$. It is also found that the saturation assumption implies the absence of a unitary singlet piece in the electromagnetic current in the symmetry limit, so that the existing particle spectrum supports the hypothesis of a pure octet transformation property for the electromagnetic current. The Drell-Hearn-Gerasimov sum rule is examined for high-spin systems, and this forward-direction sum rule would

appear to require towers of states for its saturation. Forward-direction sum rules for the nonflip Compton amplitude, based on the absence of fixed or moving poles in the J plane with I = 2, are also considered and found to be consistent with the results obtained from the magnetic-moment sum rules. (auth)

**46487** SPECTRAL-FUNCTION SUM RULES WITH SYMMETRY BREAKING. Akiba, Tomoya; Kang, Kyungsik (Brown Univ., Providence). Phys. Rev., 172: 1551-3(Aug. 25, 1968).

The symmetry breaking based on Okubo's ansatz is considered to modify Weinberg's spectral-function sum rules (particularly the second). The modified sum rules are then to the chiral U(3) × U(3) and physically interesting results are obtained for the mass relation and mixing angles of the vector mesons, a nonet assignment of the axial-vector mesons, and the decay constants of the pseudoscalar mesons. (auth)

**46488** DIVERGENCES OF WEAK NONLEPTONIC AMPLITUDES AND THE BREAKING OF $SU_3 \times SU_3$. Bouchiat, C.; Iliopoulos, J.; Prentki, J. (CERN, Geneva). Nuovo Cim., 56A: 1150-4(Aug. 21, 1968).

The effects of the SU(3) × SU(3) breaking of the divergences of the weak nonleptonic processes are examined. It is shown that, in the general case, the symmetry breaking introduces higher-order divergences. It is also shown that these terms can be eliminated under certain assumptions concerning the transformation properties of the symmetry-breaking Lagrangian. (L.B.S.)

### Applications (Strong)

*Refer also to abstract 46395.*

**46489** SYMMETRY BREAKING IN THE SU(3) CHIRAL DYNAMICS. Minamikawa, Toshiyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 39: 1605-6(June 1968).

A generalization of the SU(2) nonlinear chiral dynamics to SU(3), which was achieved previously on the basis of the quark model is considered taking SU(3) symmetry breaking into account. Baryon–meson interactions and the mass difference of spin-1 mesons are discussed. Some coupling constants and predicted mass levels are shown. (J.F.P.)

**46490** EXPERIMENTAL ANALYSES OF THE SU(3) SYMMETRY IN HIGH ENERGY TWO-BODY AND QUASI-TWO-BODY SCATTERING. Fujimura, Kimio; Kobayashi, Tsunehiro; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 39: 1501-26(June 1968).

Validity of the SU(3) symmetry of the high-energy two-body and quasi-two-body reaction is investigated in a small momentum transfer region by analyzing the experimental data. The scattering amplitudes are represented in terms of the t-channel amplitudes which are specified by the SU(3) multiplet, the hyperchange and the isotopic spin in the t-channel. Furthermore the octet and singlet dominance is assumed, because the assumption seems to be consistent with the experimental data presently available. It is shown that the SU(3) symmetry is not seriously broken in the reactions for the type of $P_8B_8 \rightarrow P_8B_8$, $P_8$ and $B_8$ being the octet pseudoscalar meson and the octet baryon, respectively. In contrast, the symmetry is shown to be broken in the decuplet baryon ($B_{10}$) production $P_8B_8 \rightarrow P_8B_{10}$. The breaking of the symmetry becomes larger with increasing energy. Angular distributions for several reactions and the real to imaginary ratios of the forward scattering amplitude for the reactions $\pi^-p \rightarrow \pi^0n$, $\pi^-p \rightarrow \eta_8n$, $K^-p \rightarrow \bar{K}^0n$ and $K^+n \rightarrow K^0p$ are predicted. (auth)

**46491** STATIC SU(6) AND FUNDAMENTAL SUBSTITUTION. Ishida, Shin; Roman, P. (Boston Univ.). Phys. Rev., 172: 1684-93(Aug. 25, 1968).

A prescription is given for avoiding the two major defects of the standard static SU(6) theory, viz., its inability to treat processes which vanish in the static limit, and the contradictory results which arise from the channel dependence of SU(6) symmetry. One crucial ingredient in the framework is called fundamental substitution, which means the substitution of a constituent quark by the corresponding antiquark, following the usual substitution law. The other essential assumption is the suppression of constituent quark-antiquark pair effects in the static limit. After formulating the framework rigorously and illustrating the procedure on a simple model, it is applied first to the analysis of the Yukawa vertex of the 56-baryon and the 36-meson multiplet. The major results are (i) A Sachs-type coupling of the $1^-$ mesons and $\frac{1}{2}^+$ nucleons is obtained. (ii) The electric-type vector-meson–nucleon interaction is pure F, and the magnetic-type is F + D with $D/F = \frac{3}{2}$, so that the experimentally observed relations between the electric and magnetic form factors of the nucleons are reproduced within the framework of the vector-meson-dominance model. (iii) The $0^- - \frac{1}{2}^+$ interaction is D + F, with $D/F = \frac{3}{2}$. (iv) Resonably well-satisfied coupling-constant sum rules are obtained. The method is then applied to the trilinear meson vertex, and leads to a well-satisfied sum rule. Finally, some related problems are discussed. (auth)

**46492** SU(3)-SYMMETRY BREAKING IN A BETHE-SALPETER BOOTSTRAP MODEL. Golowich, E. (Carnegie-Mellon Univ., Pittsburgh. Univ. of Massachusetts, Amherst). Phys. Rev., 172: 1834-43(Aug. 25, 1968).

A bootstrap model is studied in detail which contains the $\frac{1}{2}^+$, $\frac{3}{2}^+$ baryon and $0^-$ meson SU(3) multiplets. The Bethe–Salpeter equation is used to ensure vertex symmetry for this multichannel system. First, the model is solved in the SU(3) limit, obtaining results in satisfactory agreement with experiment. Then, the mesons are allowed to interact with their correct isospin-invariant masses. This leads to driving shifts in baryon variables which agree impressively with experiment. These baryon shifts, fed back into the meson channel in a Fermi-Yang-type model, lead to a qualitatively correct meson mass spectrum and in particular imply a deeply bound pion. Finally, the feedback properties of the model are examined and it is found that dominant dissymmetry modes transforming as 8 and 27 are present. (auth)

**46493** THE $G_u$-PARITY. Santangelo, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 56A: 1129-30(Aug. 21, 1968).

It is shown that those mesons which are eigenstates of the $G_u$-parity concerning the u-spin can be explicitly labeled, similarly to what is usually done for the mesons which are eigenstates of the G-parity relative to the I-spin. (L.B.S.)

## Field Theories

### General

**46494** CHARGED PARTICLELIKE SOLUTIONS TO NONLINEAR COMPLEX SCALAR FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.), 9: 999-1002(July 1968).

It is shown that spatially localized singularity-free particlelike solutions exist for Lorentz-covariant complex scalar field theories with minimal gauge-invariant electromagnetic coupling, a positive-definite energy density, and suitably prescribed nonlinear self-interaction. Such a theory provides a perfectly consistent structural model on the classical level for a charged elementary particle of finite positive energy. (auth)

### Quantum Field Theory

*Refer also to abstracts 46354, 46371, 46372, 46398, 46557, and 46558.*

**46495** (DESY-68/36) ASYMMETRICAL PAIR PRODUCTION IN QUANTUM ELECTRODYNAMICS WITH MODIFIED FERMION PROPAGATOR. Fraas, H. (Wuerzburg Univ. (West Germany)). June 1968. 12p. Dep.

One- and two-photon vertices are constructed which restore gauge-invariance of the amplitude for pair production in QED with modified fermion propagator. By means of the modified Bethe–Heitler cross section, the sensitivity of asymmetrical pair production against a modification of the fermion propagator is discussed and compared with that of wide-angle production of symmetrical pairs. (auth)

**46496** UNITARITY OF PAULI TRANSFORMATIONS. Streit, L. (Syracuse Univ., N. Y.). Nuovo Cim., 57A: 140-3(Sept. 1, 1968).

Canonical transformations are studied which mix pairs of fermion excitations in a second quantized theory and it is shown how their unitarity depends on the given representation of the canonical anticommutation relations. (auth)

**46497** BEHAVIOR OF INTERACTING FIELDS ON THE LIGHT CONE. Marioni, C. (Univ., Milan). Nuovo Cim., 57A: 69-81 (Sept. 1, 1968).

A scalar-meson field coupled with a fermion field is considered and the behavior on the light cone of an ensemble of classical solutions that vanish for spacelike separation is studied. It is shown that the leading singularity of the meson field on the light cone is given by a $\delta$-function. On the contrary the fermion field cannot have $\delta$- or $\delta'$-singularities on the light cone. These results are connected with a $q$-number theory along the lines of the Heisenberg philosophy and indicate that the assumption of a positive definite metric is not consistent with the other assumptions of conventional quantized field theory. (auth)

**46498** PARTICLELIKE SOLUTIONS TO NONLINEAR COMPLEX SCALAR FIELD THEORIES WITH POSITIVE-DEFINITE ENERGY DENSITIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.), 9: 996-8(July 1968).

It is shown that a self-interacting complex scalar field theory with a positive-definite energy density can admit spatially localized singularity-free particlelike solutions. A condition on the self-interaction energy density, sufficient to guarantee the existence of such solutions, is that its derivative should be nonincreasing and not identically constant as the squared absolute value of the field increases from zero. (auth)

**46499** SOME ASPECTS OF FIELD SYMMETRIES. Scharfstein, H. Phys. Rev., 172: 1828-33(Aug. 25, 1968).

An attempt is made to derive some symmetries exhibited by elementary particles in their interactions from Schwinger's action principle. The selection rules qualitatively obtained are suggestive of strangeness, isotopic spin, and the $\Delta Q = \Delta S$ rule observed in some weak decays. For a suitable choice of relative magnitudes of coupling constants it is possible to obtain the Prentki-d'Espagnat Hamiltonian from the operator representation considered. (auth)

**46500** TREE GRAPHS AND CLASSICAL FIELDS. Boulware, David G. (Univ. of Washington, Seattle); Brown, Lowell S. Contract RLO-138813. Phys. Rev., 172: 1628-31(Aug. 25, 1968).

The classical field produced by a prescribed external source is shown to be the generating functional of the tree-graph approximation to the corresponding quantum field theory. (auth)

**46501** DRESSED-ELECTRON STATIONARY STATES IN QUANTUM ELECTRODYNAMICS. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., 172: 1632-4(Aug. 25, 1968).

The Rayleigh-Ritz procedure for functionalities is used to make a partial determination of the approximate stationary states associated with a free relativistic electron. (auth)

**46502** SYSTEMATIC RENORMALIZATION PROCEDURE FOR THE N-QUANTUM APPROXIMATION. Halprin, Arthur (Univ. of Delaware, Newark). Phys. Rev., 172: 1495-1502 (Aug. 25, 1968).

The central idea of Greenberg's N-quantum approximation (NQA) is formulated as a power-counting procedure. This allows for a more direct application of the NQA idea. Applied to the Lee model, this reformulation yields results identical to those obtained by Pagnamenta. The procedure is also applied in the lowest two orders to the relativistic $A(x)^3$ interaction. The lowest-order results differ in a nontrivial way from those obtained by Greenberg. The power-counting procedure cannot be applied to the $A(x)^3$ model quite as straightforwardly as to the Lee model. However, with the Lee-model results at hand, the modifications necessary to produce equations that have a finite term-by-term iterative solution suggest themselves quite naturally. (auth)

**46503** NONEXISTENCE OF SELF-CONJUGATE PARTICLES WITH HALF-INTEGRAL ISOSPIN. Yee, D. D. H. (Polytechnic Inst. of Brooklyn). Phys. Rev., 172: 1537-8(Aug. 25, 1968).

A proof of the nonexistence of self-conjugate isospin multiplets with half-integral isospin but with any spin is presented. The proof is based on a Lorentz- and isospin-covariant field equation, describing a self-conjugate isospin multiplet of fields of isospin I and of spin s, together with the usual representation of its solutions in terms of particle creation and annihilation operators. No assumptions are made with regard to local commutativity, the usual connection between spin and statistics, or the CPT theorem. (auth)

**46504** CANONICAL REPRESENTATION OF SUGAWARA'S THEORY. Bardakci, K.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., 172: 1542-50(Aug. 25, 1968).

Canonical Lagrangian representations of Sugawara's theory of currents are presented. Although there are some important differences, these Lagrangians resemble currently discussed phenomenological Lagrangians. (auth)

**46505** LOCAL FIELD THEORY AND ISOSPIN INVARIANCE. III. INTERACTIONS OF SELF-CONJUGATE ISOFERMION FIELDS. Carruthers, P. (Univ., Rome. Cornell Univ., Ithaca, N. Y.). Phys. Rev., 172: 1406-12(Aug. 25, 1968).

Interactions involving self-conjugate fields of arbitrary spin and half-integral isospin are studied. (The abbreviation SCIF is used for "self-conjugate isofermion.") In the absence of interactions, SCIF theories are nonlocal but relativistically covariant. In the presence of interactions, the covariance is lost because the interaction Hamiltonian density fails to commute with itself at spacelike separations. Typical interactions involving SCIF's either contain no pair (creation and destruction) terms or only pair terms. Thus, in general, crossing symmetry is lost. A model is exhibited in which the "invariant" scattering amplitude is not a Lorentz-invariant function of Lorentz scalars. In a crossed channel the scattering amplitude vanishes identically. Strong, electromagnetic, and weak interactions of SCIF's are studied with emphasis on the experimental properties of such objects. SCIF's can only interact in pairs with photons and normal hadrons because of selection rules, independently of the proportionality factor between charge Q and isospin component $I_3$. A SCIF is stable under strong and electromagnetic interactions. SCIF's can be produced in pairs through strong and electromagnetic interactions, the latter only if aided by strong interactions. If the SCIF charges are half-integral, the current–current weak interaction can lead to SCIF pair production with the aid of the strong interactions, when the SCIF field contributes to the weak current. The possibility of the W meson being a SCIF is investigated. Identifying $W^{\pm}$ with the $I_3 = \pm\frac{1}{2}$, $Q = \pm 1$ members of a SCIF isospin doublet, we have two distinct types of coupling. The charged current $J^+$ can be coupled to $(W^+, W^{+*})$ or to $(W^{-*}, W^-)$ ($W^{+*} \neq W^-$ for SCIF theories). Neither $J \cdot W$ coupling is CPT invariant but the effective $J \cdot J$ coupling is CP, T, and CPT invariant if only one of the possibilities is employed. (We specialize to the case of a T-invariant theory.) If instead we couple one current to $(W^+, W^{+*})$ and another to $(W^{-*}, W^-)$, the effective current-current interaction involving cross terms is CP-noninvariant. This CP-violating interaction is noncovariant and involves an energy dependence roughly of the form $\Delta E/m_W$, where $\Delta E$ is the mean energy transferred by the currents. (auth)

**46506** IS THE SPECIAL THEORY OF RELATIVITY WRONG? Burt, E. G. C. (RAE, Farnborough, Eng.). Nature (London), 219: 790-3(Aug. 24, 1968).

Since the publication of Professor Dingle's article (Nature, 216, 119; 1967), arguing that the special theory of relativity is incorrect, several comments have been received, and it is proposed to publish a selection of these. Comments by E. G. C. Burt (RAE, Farnborough, Eng.), W. S. Brown (Geriot-Watt Univ., Edin.) and J. L. Synge (Dublin Inst. Advanced Studies) are included in this issue. (UK)

**46507** DYNAMICS AT HIGH MOMENTUM AND THE VERTEX FUNCTION OF SPINOR ELECTRODYNAMICS. Jackiw, Roman (CERN, Geneva. Harvard Univ., Cambridge, Mass.). Ann. Phys. (N. Y.), 48: 292-321(June 2, 1968).

A modification of Feynman rules is developed such that the high-energy asymptotic forms of individual Feynman diagrams or of the complete n-point functions are obtainable. The modifications are similar to those discovered by Weinberg in connection with the dynamics at infinite momentum. The present techniques are used to obtain the high-energy behavior of the vertex of spinor electrodynamics. It is suggested that the result on the mass shell and large, spacelike momentum transfers is $\exp[-(e^2/16\pi^2) \log^2(|k^2|/\mu^2)]$ when all crossed diagrams are included. The off-mass-shell asymptotic form is also obtained and found to agree with previous results. The Bethe–Salpeter kernel, occurring in the integral equation for the vertex, is given in the relevant energy regions. (auth)

**46508** INTERPRETATION OF RELATIVISTIC WAVE EQUATIONS. Zemach, C. (Univ. of California, Berkeley). pp 389-425 of Selected Topics in Solid-State and Theoretical Physics. Bemporad, Manuel; Ferreira, Erasmo (eds.). New York, Gordon and Breach Science Publishers, 1968.

A qualitative and interpretative treatment of the relativistic wave equation is presented, with particular emphasis of the Bethe–Salpeter equation. The topics discussed include the Klein-Gordon equation, asymptotic form of the wave equation, the Wick rotation, unitarity and other properties of the scattering amplitude, normalization and orthogonality of bound-state wave functions, the nonrelativistic and Klein-Gordon limits of the Bethe–Salpeter equation, and "extra" solutions of the Bethe–Salpeter equation. (L.B.S.)

**46509** NONLOCALIZABLE THEORIES AND THE ZERO-CHARGE PROBLEM. Voronov, B. L. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 54: 1816-28(June 1968). (In Russian).

The connection between the behavior of the interaction at high energy and the requirement of localizability of the theory (according to A. Jaffe or Meimann, Guttinger) is stated. The familiar Lehmann–Simanzyk–Zimmermann theorem concerning the decrease of the vertex function is generalized for the case of localizable theories. As is well known, vanishing of the renormalized charge in some models or in the approximate solutions of the local quantum field theory equations is due to violation of the necessary conditions of the theorem. The possibility of nonlocalizable theories in the framework of the dispersion approach

is discussed, the analytical and spectral properties being conserved. Obviation of the "zero-charge" difficulty is connected with transition to the nonlocalizable theories. The latter appears to be equivalent to a redetermination of the T-product by means of infinite series of derivatives of the δ-function such that the increase of matrix elements at infinity in momentum space is exponential. The relation between nonlocalizability and nonlocality is considered. Nonlocalizable solutions are found for the simple models for which there is a "zero-charge" problem in the local theory. The degree of nonlocality of the solutions is established as well as their relation to the renormalized series. It is found, in particular, that the renormalized series of perturbation theory may be an asymptotic expansion of the exact solution. (auth)

**46510** CARGESE LECTURES IN PHYSICS. VOLUME 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968. 430p. $10.25 (Paperback); $24.50 (Hardbound).

There were 14 lectures. Separate abstracts were prepared for 11 lectures. Other lectures not abstracted covered nonlinear optics, quantum theory of optical coherence, and photon counter distributions and field statistics. These appeared in outline form, or as a reference list. (J.F.P.)

*For abstracts of individual lectures see: 45966, 46371, 46372, 46445, 46511–46516, and 46558.*

**46511** LAMB SHIFT EXPERIMENTS. Robiscoe, R. T. (Univ. of Michigan, Ann Arbor). pp 3-53 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

A review of Lamb shift experiments is given in which the manifold details of a high-resolution experiment are examined. Recent measurements relating to values of the fine structure constant $\alpha$, the quantitative features of the original Lamb–Rutherford experiments and of the level crossing work are discussed. Some necessary arithmetic for analysis of the quenching resonance line-shape to within $1/10^3$ of its line-width is described. The level crossing Lamb shift is reconciled with the original Lamb value. Finally, other Lamb shift measurements in hydrogenlike atoms are reviewed. (J.F.P.)

**46512** (g–2) EXPERIMENTS ON THE ELECTRON AND MUON AND RELATED TOPICS. Farley, F. J. M. (Royal Military Coll. of Science, Wiltshire, Eng.). pp 55-117 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

The (g–2) experiments for the electron and positron and for $\mu^+$ and $\mu^-$ are discussed. Also the determination of e/mc for the muon by measuring the precession frequency for $\mu^+$ at rest is described. Quantum electrodynamics is briefly reviewed from an experimental point of view. (J.F.P.)

**46513** QUANTUM THEORY OF A DIELECTRIC AND A LASER. Thirring, W. (Univ., Vienna). pp 395-413 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

The quantum dynamics of three systems where the electrodynamic field interacts with matter is studied. These systems are a model for an atom interacting with the radiation field, the interaction of the field with many atoms which are represented by a continuum of oscillators distributed uniformly in space, and the same system but with oscillators of negative energy. Canonical theory is used, and an explicit solution of the equations of motion is given where the canonical commutation relations are satisfied by simple operators like creation and destruction operators. (J.F.P.)

**46514** QUANTUM ELECTRODYNAMICS AT HIGH ENERGIES: WIDE ANGLE LEPTON PAIR PRODUCTION. Joos, P. (DESY, Hamburg). pp 119-52 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

Experiments for the wide-angle lepton pair production, as a test of quantum electrodynamics, are reviewed. Electron and muon pair production is discussed, and possible experiments using electron–electron and electron–positron storage rings are mentioned. The leptonic decay of the meson (ρ) is briefly considered. (J.F.P.)

**46515** RENORMALIZATION THEORY. Yennie, D. R. (Cornell Univ., Ithaca, N. Y.). pp 153-90 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

A detailed pedagogical discussion of renormalization theory is given. Beginning with a review of standard material, the general terminology and formal algebra of renormalization is presented in which it is shown how a particular subtraction scheme gives a multiplicative renormalization; ultimately it is shown how this also renders the theory finite. Intermediate amplitudes are discussed where a rule for extracting a finite part of any Feynman integral is given; this rule consists of certain Q-operations to be applied to the integral. It is demonstrated that intermediate amplitudes are finite renormalized amplitudes, but not yet conventionally renormalized. The final step to the usual renormalization is straightforward and finite. Finally some consequences of renormalization related to the renormalization group arguments are covered. (J.F.P.)

**46516** RELATIVISTIC TREATMENT OF SOME SIMPLE ATOMS. Guerin, F. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 191-208 of Cargese Lectures in Physics. Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

The relativistic method for treating a bound state is presented as it was established by Salpeter. Confrontation between theory and experiment is possible in several cases. There is a discrepancy for the ground state hyperfine splitting in hydrogen. This splitting is sensitive to details of proton structure. Uncalculated parts of the proton structure corrections are estimated. (J.F.P.)

## *Gravitation and General Relativity*

*Refer also to abstracts 45845, 45874, 45878, and 46475.*

**46517** EXTERNAL FIELD OF A RADIATING CHARGED PARTICLE IN GENERAL RELATIVITY. Shah, Yashodhara P. (Gujarat Univ., India). Curr. Sci. (India), 37: 429-30(Aug. 5, 1968).

A line element describing the external field of a radiating charged particle is reported. The expanding zone of pure radiation, which itself is the seat of an electromagnetic field, in addition to the Coulomb field due to the central charge, is considered which exists in the space around the radiating charged particle. (J.F.P.)

**46518** COMMENTS ON THE SCALAR–TENSOR THEORY. Bergmann, Peter G. (Syracuse Univ., N. Y.). Int. J. Theor. Phys., 1: 25-36(May 1968).

Scalar-tensor theories are discussed as encompassing three classical long-range fields, including the electromagnetic field. In order to shed additional light on the restrictive assumptions made by Dicke concerning the coupling of the scalar field with matter, the ponderomotive laws of a scalar-tensor theory are constructed free of approximations in the form of integral laws. The integrals are extended over two- and three-dimensional domains that lie entirely in empty space but surround the regions containing matter; as for the latter, the vacuum field equations are not required to hold, but no further assumptions are made. It turns out that the gradient of the incident scalar field will contribute to the rate of change of the mass and linear momentum of a "particle" an amount proportional to that particle's scalar-field source strength, which in turn is an arbitrary function of time, unless Dicke's special restriction is imposed. To this extent the motion of a test particle is indeterminate, contrary to experience. (auth)

**46519** POSSIBLE VERIFICATION OF THE EQUIVALENCE PRINCIPLE (FOR ATOMIC PHENOMENA) IN THE SECOND AND HIGHER ORDERS IN THE NEWTONIAN GRAVITATIONAL CONSTANT. Naida, O. N. JETP Lett. (USSR) (Engl. Transl.), 17: 370-2(June 20, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 7: 481-4(June 20, 1968).

It is shown that violation of the equivalence principle in the relativistic equations for the electron in the presence of a gravitational field could lead to a new observable effect, the anomalous red shift of the spectral lines of a source, the hydrogen atom, situated in a gravitational field. The anomaly would consist in the fact that the coefficient of proportionality of the wavelength received from the indicated source to the corresponding laboratory wavelength would be different for different spectral lines. To verify whether this anomaly exists in the second and higher orders in G, it is proposed to carry out spectroscopic measurements on light from quasars, where $z \geq 1$. The linear theory of gravitation and also the Thirring nonlinear theory as applied to the hydrogen atom or to a hydrogenlike ion are considered. (J.F.P.)

**46520** KLEIN–GORDON GEON. Kaup, David J. (Univ. of Maryland, College Park). Phys. Rev., 172: 1331-42(Aug. 25, 1968).

A study of the spherically symmetric eigenstates of the Klein-Gordon Einstein equations (Klein-Gordon geons) reveals that these geons have properties that are uniquely different from other gravitating systems that have been studied. The equilibrium states of these geons seem analogous to other gravitating systems; but when the question of stability is considered from a thermodynam-

ical viewpoint, it is shown that, in contrast with other systems, adiabatic perturbations are forbidden. The reason is that the equations of state for the thermodynamical variables are not algebraic equations, but instead are differential equations. Consequently, the usual concept of an equation of state breaks down when Klein-Gordon geons are considered. When the question of stability is reconsidered in terms of infinitesimal perturbations of the basic fields, it is then found that Klein-Gordon geons will not undergo spherically symmetric gravitational collapse. Thus, Klein-Gordon geons are counterexamples to the conjecture that gravitational collapse is inevitable. (auth)

**46521** EXACT INTERNAL SOLUTIONS FOR DENSE MASSIVE STARS. Durgapal, M. C.; Gehlot, G. L. (Univ. of Jodhpur, India). Phys. Rev., 172: 1308-9(Aug. 25, 1968).

A model is proposed in which the central pressure and density are infinitely large, but the mass contained in an arbitrary radius $\epsilon(m_\epsilon = \int_0^\epsilon 4\pi\rho r^2 dr)$ is finite. A new m/a ratio has been found: $m/a = n/(2n + 1)$, where n can take values $0 < n \leq 2$. Further, it is proved that the Schwarzschild radius is unattainable. (auth)

**46522** SUPPLEMENTARY CONDITIONS IN QUANTIZED GRAVITATIONAL THEORY. Gupta, Suraj N. (Wayne State Univ., Detroit). Phys. Rev., 172: 1303-7(Aug. 25, 1968).

The role of the supplementary conditions in the quantum theory of gravitation is discussed in a simplified and unambiguous manner by means of a Lagrangian formalism involving the use of the ordered products. The consistency of the supplementary conditions for the general nonlinear gravitational field interacting with the matter field is established. (auth)

**46523** DERIVATION OF NEWTON'S LAW OF GRAVITATION FROM GENERAL RELATIVITY. Katz, Amnon (Argonne National Lab., Ill.). J. Math. Phys. (N. Y.), 9: 983-5(July 1968).

A static situation of two objects held apart by a strut is considered within the framework of general relativity, and the gravitational attraction between the objects is inferred from the stress in the strut. In the Newtonian limit — the objects are well separated and the field weak everywhere except in their immediate vicinity — Newton's law of gravitation is reproduced. This check goes well beyond verifications of the Newtonian limit based on considerations of "test particles," since arbitrarily strong self-fields are not excluded for either object. It is also an explicit verification of the equality of active and passive gravitational masses. (auth)

**46524** ROTATION AND LORENTZ GROUPS IN A FINITE GEOMETRY. Beltrametti, E. G. (Univ., Genoa. INFN, Genoa); Blasi, A. A. J. Math. Phys. (N. Y.), 9: 1027-35(July 1968).

The introduction in physics of a finite geometry approximating the ordinary Euclidean one poses the problem of studying the relativity groups over such a geometry. A detailed analysis of the structure and irreducible representations of the rotation, Lorentz, and Poincaré groups is presented. It is found that, besides the usual quantum numbers, a new two-valued label is necessary to specify the representations. (auth)

**46525** TYPE-NULL VACUUM SOLUTIONS IN GENERAL RELATIVITY. Misra, M. (Gujarat Univ., Ahmedabad, India). J. Math. Phys. (N. Y.), 9: 1052(July 1968).

It is shown that the necessary and sufficient conditions for the vacuum solutions of a certain metric to be of type null according to the Pirani–Petrov classification are that a certain other metric be conformally flat. The general solution is obtained. (auth)

**46526** RADIATING SPHERES IN THE SCALAR–TENSOR THEORY OF GENERAL RELATIVITY. Kaufmann III, William J. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.), 9: 1053-7 (July 1968).

Using Bondi's "radiation coordinates," the Brans–Dicke field equations describing the interior of a sphere consisting of a perfect fluid and a radiation field, part of which is purely isotropic and the remainder of which is purely radial, are stated. A method for seeking solutions to these equations in the radiation-filled space outside the sphere is given. (auth)

**46527** POSSIBILITY OF GENERALIZED GRAVITATIONAL FIELD EQUATIONS. Romanov, Yu. A. Dokl. Akad. Nauk SSSR, 181: 53-5(July-Aug. 1968). (In Russian).

The procedure for deriving gravitational field equations on the basis of the mode of least action of gravitational fields was analyzed using a method which, while conserving the positiveness and invariability of the second action variation, reduced the equations to a mode which differs from Einstein's equations by the presence of additional vector field $A_i$. The properties of the obtained equations are analyzed and the feasibility of physical interpretation of $A_i$ as a vector-potential of electromagnetic field is discussed. (R.V.J.)

**46528** A SOLUTION TO EINSTEIN'S GRAVITATIONAL FIELD EQUATION FOR A SPHERICALLY SYMMETRICAL STATIC PERFECT FLUID. Hewett, Lionel Donnell. Rolla, Mo., Univ. of Missouri, 1965. 77p.

Thesis.

Given spherical symmetry, Einstein's gravitational field equations are reduced to a single, second order, linear, homogeneous differential equation. The solution of this equation for a homogeneous sphere is identical with Schwarzschild's solution. The equation is solved for a centrally dense star: $T_4^4 = K(r_0 + r)^{-4}$, with parameters K and $r_0$ adjusted to fit the sun. Values of relative density, interior mass, relative pressure, relative and absolute temperature are obtained as functions of radius, r, and are compared with corresponding values for the homogeneous sphere, and for a model sun. (Disser. Abstr.)

**46529** CAUCHY PROBLEM IN THE SCALAR–TENSOR GRAVITATIONAL THEORY. Cocke, W. J.; Cohen, Jeffrey M. (Goddard Space Flight Center, New York). J. Math. Phys. (N. Y.), 9: 971-3 (July 1968).

It is shown that the scalar–tensor gravitational field equations can be split up into a set of initial-value equations and a set of time-evolution equations and that the initial-value equations preserve their form as they propagate forward in time. The proper amount of freedom for the stress–energy tensor is maintained, and the Cauchy problem is thus posed reasonably well. (auth)

**46530** PROBLEM OF AN EXPERIMENTAL VERIFICATION EQUALITY OF INERT AND GRAVITATIONAL MASSES. Linets, A. M. Zh. Eksp. Teor. Fiz., 54: 1772-4(June 1968). (In Russian).

It is pointed out that rigorous equality between the inert and gravitational masses is not an unambiguous logical corollary of the available experimental data since the results of the Galilei, Newton and Eötvös experiments can be explained in an alternative manner. The available direct experiments are too few and do not possess the required accuracy. (auth)

## Scattering Theory

**46531** (JINR–E2-3917) SUMMATION OF ASYMPTOTICS IN PERTURBATION THEORY AND HIGH-ENERGY BEHAVIOUR. Efremov, A. V.; Ginzburg, I. F.; Serbo, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 23p. (CONF-680809–16). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Assuming the bare charge to be finite a summation was made of the senior asymptotical terms of all the Feynman graphs in the theory $g\bar{\psi}\gamma^5\psi\phi + h\phi^4$. As a result the square-root branching points on j-plane appear. This leads to a decrease of the total cross section of pion and nucleon scattering not slower than $[\log(2E_{lab}/m)]^{-\frac{1}{2}}$ in the energy region 1 GeV $\ll E_{lab} \lesssim$ 200 GeV and the ratio Re T/Im T $\approx [\log(2E_{lab}/m)]^{-1}$. The factorization relation, $\sigma_{\pi\pi}\sigma_{nn} = \sigma_{\pi n}^2$ is automatically fulfilled. (auth)

**46532** (JINR–E2-3949) RELATIVISTIC TWO BODY PROBLEM AND FINITE-DIFFERENCE CALCULUS. Kadyshevskii, V. G.; Mir-Kasimov, R. M.; Skachkov, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 25p. Dep.

For the purpose of solving the relativistic Schrodinger finite–difference equation, a special type of finite–difference calculus is developed. Solutions of the above equation in the absence of interactions are investigated, and the relativistic analogs of Wronskians and Green functions are found. (auth)

**46533** (JINR–E2-3950) SCHROEDINGER DIFFERENCE EQUATION FOR TWO RELATIVISTIC PARTICLES IN THE SIMPLEST CASES. Kadyshevskii, V. G.; Mir-Kasimov, R. M.; Skachkov, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 20p. Dep.

On the basis of the relativistic finite-difference Schroedinger equation the relativistic analogs of the current, continuity equation, and phase shifts are introduced. Exact solutions of some problems with simple potentials were found. (auth)

**46534** (JINR–P2-3833) ASYMPTOTICS OF THE FEYNMAN GRAPHS. Ginzburg, I. F.; Efremov, A. V.; Serbo, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 10p. (In Russian). Dep.

The recipe of extracting the asymptotics of any Feynman graph in the theory with $L = g\bar{\Psi}\Gamma\Psi\phi + h\phi^4$ ($\Gamma = 1$ or $\gamma^5$) is described. (auth)

**46535** (JINR–P2-3944) EXCHANGE DEGENERACY AND RELATIONS BETWEEN CROSS-SECTIONS AT HIGH ENERGIES.

Mir-Kasimov, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. (In Russian). Dep.

A number of relations are obtained between the cross sections of meson–nucleon and nucleon–nucleon collisions at high energies in the scheme using the Regge pole theory and the exchange degeneracy hypothesis. (auth)

**46536** GENERALIZED LOVELACE EQUATION IN THE RELATIVISTIC FADDEEV FORMALISM. II. Mishima, Nobuhiko (State Univ. of New York, Buffalo); Oryu, Shinsho; Takahashi, Yasutaro. Progr. Theor. Phys. (Kyoto), 39: 1569-84 (June 1968).

By using the relativistic Faddeev formalism for three-particle scattering based on the techniques of Blankenbecler and Sugar to multiladder diagram, a generalized relativistic Lovelace equation is proposed for composite-particle scattering in order to treat bound states and unstable particles in a unified way. In order to obtain our equation from the relativistic Faddeev formalism, relativistic off-shell form factors and propagators corresponding to composite particles are introduced by applying the Fredholm theory to the Blankenbecler–Sugar kernel of the two-body scattering equation. These functions, the off-shell form factors and propagators, are defined by an analytic extension from the energy of bound state or resonance state and the two-body scattering matrix can be separated into a part including a composite-particle pole and a remaining part. By use of these functions, a generalized Lovelace equation for composite particle scattering can be derived as an analytically extended equation of the so-called Lovelace equation given by Freedman, Lovelace and Namyslowski. From the analytically extended properties of these functions, it is emphasized that the equation is more useful in applying to unstable particle scattering and also to production process enhanced by final interaction in the relativistic three-body scattering problems. (auth)

**46537** MULTIPLE POLES IN THE SCATTERING GREEN'S FUNCTION AND THE LIGHTLIKE LIMIT OF THE BETHE–SALPETER AMPLITUDE. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 39: 1585-97(June 1968).

It is investigated how the Bethe–Salpeter amplitudes behave, when the bound-state four-momentum tends to a lightlike vector, in the ladder model in which two scalar particles exchange scalar particles having mass $\mu$. For $\mu \neq 0$, it is inferred that the scattering Green's function has multiple poles at $s = 0$, where $s$ stands for the invariant total energy squared, by proving that certain Bethe–Salpeter amplitudes are missing at $s = 0$ in the equal-mass case. Some evidences of the existence of multiple poles are pointed out also in the unequal-mass case with $\mu \neq 0$. (auth)

**46538** CURRENT ALGEBRA AND FIXED J-PLANE SINGULARITIES. Dosch, H. G. (Massachusetts Inst. of Tech., Cambridge); Gordon, David. Nuovo Cim., 57A: 82-92(Sept. 1, 1968).

A systematic study of the consequences of Fubini–Dashen–Gell-Mann sum rules for all t-channel helicity amplitudes is given. The necessity of Kronecker deltas in all sense-sense amplitudes at J = I is pointed out. The coefficients of these Kronecker deltas are, apart from kinematical factors, the form factors of the target particles. (auth)

**46539** NOTE ON THE FROISSART BOUND. Bodine, N. R. (Univ. of Washington, Seattle). Nuovo Cim., 57A: 49-53(Sept. 1, 1968).

The bound on the scattering amplitude, $|M| = O[(\text{energy})^2 \cdot \log^2(\text{energy})^2]$ derived by Froissart for spinless particles is extended to include particles with spin. The result rests on the assumption of the analytic properties of amplitudes for particles with spin. Helicity amplitudes are used in order that the result be valid if zero-mass particles are involved. (auth)

**46540** TENSOR DECOMPOSITION OF THE TRANSITION OPERATOR. Kowalski, K. L. (Case Western Reserve Univ., Cleveland). Nuovo Cim., 57A: 39-44(Sept. 1, 1968).

The properties of the tensor components of the transition operator with respect to an arbitrary compact group are investigated. The principal result is that as a consequence of unitarity the transition operator always has an invariant component whose imaginary part is nonnegative. The connection of this result with the consistency of phenomenological calculations in broken-symmetry models is discussed. (auth)

**46541** SCATTERING MODEL FOR A NEUTRAL SELF-CONJUGATE PARTICLE. Cheung, F. F. K. (State Univ. of New York, Stony Brook). Nuovo Cim., 57A: 158-64(Sept. 1, 1968).

An attempt is made to obtain a solvable scattering model satisfying the basic principles of the local quantum field theory such as Lorentz covariance, crossing and unitarity relations. The iterative method of obtaining approximate solutions for the dispersion and unitarity relations for the two-body scattering amplitude of a neutral, self-conjugate field is considered. (L.B.S.)

**46542** PHASE CONTOURS OF SCATTERING AMPLITUDES. III. HIGH-ENERGY BEHAVIOR AT FIXED ANGLES. Eden, Richard J.; Tan, Chung-I. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 172: 1583-9(Aug. 25, 1968). (UCRL-17923).

The method of phase contours is applied to some problems concerned with scattering at fixed angles. The crossing-symmetric generalized Regge model developed in a previous paper is used to illustrate possible characteristics of the behavior of scattering amplitudes. These characteristics are discussed both in the complex energy plane at fixed angle and in the complex cos $\theta$ plane at fixed high energy. The former leads to a procedure for studying fixed-angle behavior by means of entire functions on whose orders some limits can be established. The latter leads to a generalization of the lower bounds on high-energy behavior obtained earlier by Cerulus and Martin, and by Chiu and Tan. (auth)

**46543** ON THE UNITARIZATION OF THE BORN APPROXIMATION. Abul-Magd, A. Y. (Atomic Energy Establishment, Cairo); Simbel, M. H. Z. Phys., 215: 121-6(1968).

A new approximation for the elastic scattering transition matrix is suggested. This approximation satisfies the unitarity condition. A modified Born series is introduced which has this unitarized Born approximation as the leading term. The series is applied to the solvable case of scattering by a separable potential and is found to converge in a wider region of energies than that of the conventional Born series. (auth)

**46544** COVARIANT VERSION OF THE BJORKEN LIMIT. Olesen, P. (Univ. of Rochester, N. Y.). Phys. Rev., 172: 1461-9(Aug. 25, 1968).

Using local-field theory and the assumption that the commutator is not more singular than $\delta(x^2)$ and derivatives of $\delta(x^2)$, it is shown that the Bjorken limit $q_0 \to \infty$, $q$ fixed, can be generalized to $|q^2| \to \infty$, $|q_\mu| \to \infty$, by making the result of the Bjorken limit covariant. If Schwinger terms are present, the Bjorken limit does not determine the leading asymptotic behavior; in spite of this, however, it is possible to show that the leading asymptotic behavior can be obtained from the Bjorken limit if the coefficients of the Schwinger terms are known, and if the amplitude satisfies a divergence equation. (auth)

**46545** BOUNDS FOR COUPLING CONSTANTS IN THE MULTI-REGGE MODEL. Kajantie, K. (Univ. of Helsinki). Phys. Rev., 172: 1470-3(Aug. 25, 1968).

An integral equation for the multi-Regge-model contribution to the total cross section of a two-particle reaction is derived using certain approximations, solved and used to determine bounds for the coupling constants in the model. These bounds limit also the behavior of the n-particle production cross section as a function of n. (auth)

**46546** CONSPIRATORS AND DAUGHTERS IN UNEQUAL-MASS, NONZERO-SPIN SCATTERING. Jacobs, Matthew A.; Vaughn, Mark H. (Univ. of California, San Diego, La Jolla). Phys. Rev., 172: 1677-83(Aug. 25, 1968).

The problem of satisfying the all unequal-mass kinematic constraint at $s = 0$ for helicity amplitudes for two-body scattering of particles with spin is analyzed in a Regge model. The Mandelstam–Sommerfeld–Watson transformation is used to obtain the form of the Regge contributions. It is shown that a sequence of daughter trajectories spaced at $\Delta\alpha = 1$ is necessary to keep the amplitude at $s = 0$. For $\mu_m = \min(|\lambda_a - \lambda_b|, |\lambda_c - \lambda_d|) = 0$, no further trajectories are needed; for $\mu_m \neq 0$ and the reduced Regge residue finite at $s = 0$, the kinematic constraint and analyticity require daughters and a conspirator sequence of opposite parity starting at $\alpha_c = \alpha_{\text{Regge}}$. It is shown to be probable that, for a residue which vanishes as $s^n$ ($n \geq \mu_m$) at $s = 0$, only the daughter trajectories are needed. (auth)

**46547** IMPACT PARAMETRIZATION OF THE SCATTERING AMPLITUDE. Chang, Ngee-Pong (City Coll., New York). Phys. Rev., 172: 1796-1806(Aug. 25, 1968).

The new impact-parameter representation is studied using $J_0(kb \sin \vartheta)$ instead of the conventional $J_0(2kb \sin \frac{1}{2}\vartheta)$. Group-theoretic arguments are given for this representation in the case of unequal-mass spinless scattering. Assuming full Mandelstam analyticity for the scattering amplitude, the analytic properties of the impact parameter amplitude $A^{(s)}(k,b)$ are described. For convenience, the masses are assumed to be equal in the discussion of analyticity. The singularity structure of $A^{(s)}(k,b)$ governs the analyticity in the l-plane of $a_l^{(s)}(k)$, the direct s-channel partial-wave amplitude. Conditions for infinitely many, one, or no (moving) Regge poles are studied. Using Serber's optical-potential

model, infinite families of poles of increasing order are found in the angular momentum plane. In connection with the Feeedman and Wang amplitude, conditions also state for there to be infinite, one or no (moving) Lorentz poles. As an example, the Coulomb potential which leads to an infinite number of Lorentz poles is quoted. Remarks are given on the actual connection with the eikonal approximation, as well as on earlier work on the impact-parameter representation involving $J_0(2kb \sin \frac{1}{2}\vartheta)$. (auth)

**46548** STATIONARY EXPECTATION VALUES AND SLOPES OF DAUGHTER REGGE TRAJECTORIES FOR THE BETHE–SALPETER EQUATION. Madan, Rabinder N.; Haymaker, Richard W.; Blankenbecler, R. (Univ. of California, Santa Barbara). Phys. Rev., 172: 1788-95(Aug. 25, 1968).

Variational techniques for the calculation of general expectation values, not just eigenvalues, for the Bethe–Salpeter equation are derived. These formulas are applied to the numerical calculation of Regge trajectories and slopes for a simple potential with spinless particles. The treatment of unequal masses as a perturbation on the equal-mass solutions is also discussed. Particular attention is paid to the problem of crossing trajectories coupled by the perturbation. It is shown that if two unperturbed trajectories cross, then a complex-conjugate pair of trajectories can result in the presence of the perturbation. (auth)

**46549** SIMULTANEOUS "PARTIAL-WAVE" EXPANSION IN THE MANDELSTAM VARIABLES: CROSSING SYMMETRY FOR PARTIAL WAVES. Balachandran, A. P. (Syracuse Univ., N. Y.); Nuyts, J. Contract AT(30-1)-3399. Phys. Rev., 172: 1821-7 (Aug. 25, 1968). (NYO-3399-144; SU-1206-144).

The amplitude for the elastic scattering of two spinless particles of equal mass $\frac{1}{2}$ is expanded in terms of eigenfunctions which form a complete set for a certain class of functions of the Mandelstam variables s, t, u ($s + t + u = 1$) and which display the threshold behavior of the partial-wave amplitudes. The eigenfunctions are generated by a partial differential operator which commutes with the total angular momentum in any of the three channels and which is invariant under s, t, u permutations. An infinite number of finite-dimensional crossing relations for the partial-wave amplitudes which are necessary and sufficient for the crossing symmetry of the total amplitude are derived, as well as an explicit form for the corresponding crossing matrices. It is shown that the Fourier coefficients of the expansion satisfy a Froissart–Gribov integral representation whose kernel is determined by the imaginary parts of the partial-wave amplitudes. (auth)

**46550** NEW PERTURBATION TREATMENT OF THE SCATTERING AND BOUND-STATE PROBLEM. Michalik, B. (Inst. of Plasma Physics, Prague). Ann. Phys. (N. Y.), 48: 197-220 (June 2, 1968).

A new object called the distortion operator is introduced into the theory and consequences of such introduction are investigated: The relation of the distortion operator to the common quantities as the transition operator and S-matrix is stated and an equation for it is deduced. This equation is shown to be nonsingular (contrary to the Lippmann–Schwinger equation). The Neumann series following from it has a greater radius of convergence than the original Born series and it converges more rapidly than the Born series does; in the first order the unitarity is satisfied. An approximation of a given interaction is obtained, and it is shown to be separable in the momentum partial wave representation. Expressions for phase shifts, scattering lengths and binding energies in the potential theory are given. Results of computations performed are encouraging; they are very similar to those following from Weinberg's quasiparticle theory. Different other methods are observed to be related to this approach either as special cases or having some of the same features. (auth)

**46551** CONSTRUCTION OF ORTHONORMAL ANGULAR-MOMENTUM OPERATORS. Corio, P. L. (Mobil Research and Development Corp., Princeton, N. J.). J. Math. Phys. (N. Y.), 9: 1067-71(July 1968).

The problem of constructing an orthonormal basis for the $(2j + 1)^2$-dimensional space of angular-momentum operators is reduced to the problem of constructing a sequence of orthogonal polynomials of a discrete real variable. A number of properties of the polynomials are obtained, including a pure recurrence formula and several mixed recurrence relations. Three explicit representations of the polynomials are given, together with a table of orthonormal angular-momentum operators. (auth)

**46552** VARIATIONAL BOUNDS FOR THE POTENTIAL IN TERMS OF THE S-WAVE PHASE SHIFT. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Corbella, O. D.; Degasperis, A.; De Stefano, M. B. J. Math. Phys. (N. Y.), 9: 1002-6(July 1968).

A variational expression involving the S-wave phase shift and bound-state parameters and the potential, which appears particularly suited to evince from the S-wave-scattering data information (i.e., bounds or variational approximations) on the potential is established. An application of this approach to solvable potentials yields a number of inequalities involving special functions. (auth)

**46553** ANALYTICITY PROPERTIES OF THE SCATTERING AMPLITUDE FOR SINGULAR POTENTIALS. Dombey, Norman (Univ. of Sussex, Eng.); Jones, R. H. J. Math. Phys. (N. Y.), 9: 986-95(July 1968).

A modified Sommerfeld–Watson transformation is established for the singular potential $V(r) = g^2r^{-4}$. The positions of the Regge poles and their residues are obtained for a general class of singular potentials and the analyticity properties of the scattering amplitude $f(k, \cos\theta)$ are discussed. (auth)

**46554** TAMM–DANCOFF METHOD IN THE 2V SECTOR OF THE LEE MODEL. Scarfone, Leonard M. (Univ. of Vermont, Burlington). J. Math. Phys. (N. Y.), 9: 977-83(July 1968).

The 2V sector of the Lee model with boson sources at zero separation is considered from the Tamm–Dancoff point of view. This involves three singular integral equations which are solved by appealing to results previously gained in the Lehmann–Symanzik–Zimmermann method of solution. Two scattering amplitudes and a production amplitude are rederived via the state vectors and an equation for the determination of the two-meson exchange potential is discussed. (auth)

**46555** BOUNDS IN SCATTERING THEORY. Johnson, Porter Wear. Princeton, N. J., Princeton Univ., 1967. 126p. Thesis.

In the main body of this thesis scattering from central potentials is considered. It is proved that with certain conditions, the scattering amplitude corresponding to such potentials exhibits Orear behavior. It is also shown that for a certain subclass of these potentials the scattering amplitude converges to its first Born term at high energies for a fixed angle of scattering. Finally a speculation is made about Orear behavior being exhibited for certain more general class of potentials. An entirely different topic is considered, namely that of solving partial wave dispersion relations with a given left hand cut discontinuity through the aid of unitarity. Two sets of necessary conditions upon the left hand cut discontinuity are obtained, and these conditions are compared with a necessary condition previously given by Martin. (Disser. Abstr.)

**46556** APPLICATION OF THE SMOOTH PERTURBATION METHOD FOR SOLUTION OF GENERAL EQUATIONS OF MULTIPLE WAVE SCATTERING THEORY. Barabanenkov, Yu. N. Zh. Eksp. Teor. Fiz., 54: 1775-84(June 1968). (In Russian).

The problem of a plane monochromatic wave (particle beam in quantum mechanics, acoustic or electromagnetic wave) incident on half-space filled with a scattering medium with large scale effective scattering potential fluctuations is considered. General equations of the Dyson type for the mean field and equation of the Bethe–Salpeter type for the field correlation function are the basis of the investigation. Simplified, purely differential equations for the mean field and field correlation function are derived in the approximation of weak nonlocality of the mass operator and intensity operator nuclei. The equation for the field correlation function thus obtained is solved by the Rytov smooth perturbation method. The relation between the solution found and the results of application of the smooth perturbation theory or Kalashnikov–Ryazanov method to the nonaveraged wave equation and also its relation to the radiation transfer equation in the small angle approximation is established. The conditions of applicability of the smooth perturbation method are formulated on basis of a calculation of the complex phase of the second approximation. Restrictions on the parameters of the problem which ensure that the method be applicable for distances of the order or larger than the extinction length are indicated. (auth)

**46557** THE CLASSICAL AND QUANTUM S-MATRIX IN THE BORN–INFELD TWO-DIMENSIONAL FIELD MODEL. Barbashov, B. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 54: 1806-15(June 1968). (In Russian).

The problem of finding the S-matrix for a nonlinear Born-Infeld scalar field in two-dimensional x, t space is considered. The "classical" S matrix which transforms the incoming wave into an outgoing one is found on basis of the exact solution of the classical field equation for the problem of scattering of two plane waves. It is demonstrated that in a certain approximation in the "nonlinearity" parameter g the quantum S matrix is identical with the "classical" matrix. In this approximation the S-matrix leads only to elastic scattering processes. (auth)

**46558** SUMMATION METHODS FOR RADIATIVE CORRECTIONS. Eriksson, Karl-Erik (Inst. of Theoretical Physics, Goeteborg, Sweden). pp 245-74 of Cargese Lectures in Physics.

Volume 2. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1968.

The summation methods for radiative corrections include soft photon radiation in scattering processes, the use of the renormalizability of quantum electrodynamics for summation of leading (logarithmic) terms in the perturbation expansion, and the application of this to scattering processes, in particular to scattering by an external potential and $\pi + e$ scattering. (J.F.P.)

**46559** N/D EQUATIONS: SELF-DAMPING MECHANISM, THRESHOLD BEHAVIOUR AND SUBTRACTED EQUATIONS, REGGE-POLE HYPOTHESIS. Cornille, H.; Rubinstein, G. (Institut de Physique Nucleaire, Orsay, France). Nuovo Cim., 56A: 867-914(Aug. 21, 1968).

The N/D equations of the Fredholm type are studied for $l \neq 0$, for "regular" left-hand cut discontinuities. The tool used is the inversion formalism from which N/D equations, if they exist, are obtained as limiting equations. On the one hand analyzing the problem of correct threshold behavior for the $S_l$ matrix reconstructed from N/D, the corresponding available subtracted equations are studied. It is found that for the l-th wave there exist $(l + 1)$ equations. For the p-th subtracted equation $(p = 0, \ldots, l)$ the following are investigated according to different discontinuities: (1) the corresponding potentials, (2) the asymptotic D behavior and the Levinson theorem, (3) the intrinsic conditions satisfied by the discontinuity, and (4) the problem of ghosts and bound states. From the considered discontinuities two different kinds of interactions are obtained: (1) leading only to Regge poles in complex l, (2) where fixed branch points occur also in complex l, and D does not go to constant asymptotically (subtracted equation). On the other hand the problem of a self-damping mechanism for "regular" discontinuities approximated by poles (or more general approximations) is discussed and the interactions are distinguished accordingly as the corresponding states satisfy or not usual spectrum requirement. In the residues of the pole space the self-damping domain of physically available interactions for the l-th wave is a connected domain and the boundary belongs to the surface such that the solutions of the l-th subtracted equations are also solutions of the $(l - 1)$-th subtracted one. (auth)

**46560** GRAND-DAUGHTER TRAJECTORY IN THE LADDER APPROXIMATION. Halliday, I. G. (Imperial Coll. of Science and Tech., London); Landshoff, P. V. Nuovo Cim., 56A: 983-1002 (Aug. 21, 1968).

The ladder approximation in perturbation theory is used with scalar particles to evaluate those Regge trajectories that go to $l = -1, -2$ and $-3$ in the zero-coupling limit. Previous results concerning those that go to $-2$ are confirmed, that is that there is a daughter and two "sisters" of the daughter. It is shown that there is a grand-daughter going to $l = -3$ and a daughter for each of the sisters, together with two further trajectories. A check is made on the coefficients of the nonleading terms in the asymptotic behavior, to verify that the contributions from parent and daughter are of the correct Regge character. (auth)

**46561** MINIMAL SOLUTIONS TO THE CONSPIRACY PROBLEM AND CLASSIFICATION OF REGGE-POLE FAMILIES. Di Vecchia, P. (CNEN, Rome); Drago, F.; Paciello, M. L. Nuovo Cim., 56A: 1185-90(Aug. 21, 1968).

Some of the results of a nongroup-theoretical approach to the conspiracy problem are given. The fundamental assumptions used are analyticity, crossing symmetry, and the factorization principle for the residue functions of the Regge trajectories. The kinematical constraints at $t = 0$ are deduced. The minimal behavior of the residue functions for the parent and daughter Regge trajectories and a classification of Regge trajectories in families are also deduced. (L.B.S.)

## Particle Accelerators

*Refer also to abstracts 45276, 45374, 46085, and 46365.*

**46562** (ANL-Trans-646) RESTRICTION OF THE BEAM CURRENT BY SPACE CHARGE IN THE JINR SYNCHROCYCLOTRON. Danilov, V. I.; Puzynin, I. V.; Safonov, A. N.; Feoktistov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report JINR-P-2912. 29p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 21: 4142. (W.H.K.)

**46563** (BNL-12756) THEORY OF DIPOLE PERTURBATIONS IN THE AGS. Herrera, J. C.; Month, M. (Brookhaven National Lab., Upton, N. Y.). June 12, 1968. 14p. Dep. CFSTI.

The motion of a particle in the Brookhaven AGS for an arbitrary distribution of perturbing dipole fields is studied. The general solution to the equation of motion is derived, and the stability and periodicity of the orbits characterizing such fields are investigated. The problem of an adiabatic increase in the perturbing dipole fields is also considered. (W.H.K.)

**46564** (CEA-R-3238(Rev.)) CALCULATION OF POLE PROFILES FOR THE DESIGN OF PARTICLE ACCELERATOR MAGNETS. CURRENT AND CONFORMAL REPRESENTATION METHODS. Jaidane, Salah (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1968. 151p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Orsay, France.

Two methods are used to determine the shape of the poles in magnets, for a given field distribution in the air-gap. The principle of the first method consists of creating the desired law of field by means of current sheets in which one can adjust the density given in a polynomial form. For the right distribution of these currents, the equipotential corresponding to the magnetic potential of the excitation coils is calculated. The pole profile of the H or C magnet identified with this equipotential line will finally take the place of the distribution of the current sheets used in the calculation. Steel permeability is assumed to be infinite and Foucault current effects are neglected in the case of variable fields. The second method consists of finding a conformal representation that maps the pole profile plane upon the upper half of another plane where the equipotentials are two half straight lines, and where the field problems are easier to solve. Steel permeability is also considered to be infinite and the coils far from the pole faces. (auth)

**46565** (CERN-68-28) PHASE ACCEPTANCE OF QUADRUPOLE DOUBLETS: ANALYTICAL APPROACH. Regenstreif, E. (Rennes Univ. (France). Faculte des Sciences. European Organization for Nuclear Research, Geneva (Switzerland)). July 22, 1968. 47p. Dep.

Analytical expressions for the phase acceptance of a quadrupole doublet are derived, taking into account practical operating conditions. The properties of a single quadrupole lens are considered, and the phase acceptance area of the doublet is calculated. The situation at the entrance of the doublet is considered. Then an application is made to the case where the two quadrupoles composing the doublet are identical. Finally, two theorems are stated which allow one to extend the theory to quadrupole triplets or more complicated systems. (W.H.K.)

**46566** (CERN-68-32) PROTON SPIN ORIENTATION. Borghini, M. (European Organization for Nuclear Research, Geneva (Switzerland)). Aug. 5, 1968. 49p. Dep.

A brief review of nuclear orientation in general and a discussion of proton polarization methods are given. The static orientation of nuclei, uses of oriented nuclei, and low temperature techniques are covered. Also covered are the static spin properties of protons, spin–lattice relaxation, the dynamic polarization of protons by electron–nucleus dipolar coupling, and thermal equilibrium polarization of nuclei by rotation in a magnetic field. (J.F.P.)

**46567** (CERN-Trans-68-7) CARACTERISTIQUES DYNAMIQUES DU SYNCHROTRON A PROTONS DE 70 GeV D'APRES LES MESURES MAGNETIQUES. (Dynamic Characteristics of a 70-GeV Proton Synchrotron According to Magnetic Measurements). Balbekov, V. I.; Shukeilo, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated into French by A. Golovanoff (CERN, Geneva), from report IHEP No. 67-58-K. 29p. (In French). Dep. CFSTI.

The effects of the deviations of the magnetic field from the distribution predicted on the movement of the particles in the Serpukov IHE proton synchrotron are considered. The calculations showed that the important azimuthal inhomogeneities of the magnetic field and the gradient are produced only at the beginning of the acceleration cycle. The half-length of the parametric resonance band for the cycle initiation field is 0.03 (in number of oscillations per revolution). When the totality of the separator is occupied, the parametric effects can cause a particle loss. The betatron oscillation frequencies are, at the interior of the work guide $9.5 < Q_{r,z} < 10.0$ for the complete cycle duration. In the induction range $H = 300$ to 11,000 oersteds, they are practically constant and equal to $Q_r = 9.72$; $Q_z = 9.65$. For $H > 11{,}000$ oersteds, the magnetic field gradient decreases because of the saturation of the magnet poles, which causes a reduction of the betatron frequencies. It is precisely this effect which determines the limiting energy of the particles. It is also seen that the quadratic nonlinearity for the beginning acceleration field is conditioned principally by the Foucault currents in the walls of the chamber. If the separator is totally occupied, the nonlinearity causes frequency fluctuations in the limits 9.6 + 9.9. A correction of the quadratic nonlinearity is apparently necessary to attain the intensity predicted in the design. (tr-auth)

**46568** (HASL-199) TRANSVERSE SHIELDING CALCULATIONS FOR THE COMPONENTS OF A 1/2 TeV PROTON SYNCHROTRON. O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Aug. 1968. 36p. Dep. CFSTI.

Neutron fluxes and dose-equivalent rates are calculated, in the $P_3$ approximation, in and through the transverse shielding of various components of a 0.5-TeV proton synchrotron; both soil and concrete were assumed as shielding materials. The neutrons were assumed to be produced by protons of various energies coming to rest in the accelerating structure after being spilled. The proton energies considered range from 25 MeV to 500 GeV. Shielding thicknesses up to 1500 g/cm$^2$ are considered. (auth)

**46569** (JINR-P9-3932) ISOCHRONOUS CYCLOTRON FOR PRODUCTION OF CHARGED PARTICLE BEAMS OF A HIGH DEGREE OF MONOENERGY (M. C.). Glazov, A. A.; Denisov, Yu. N.; Dzhelepov, V. P.; Dmitrievskii, V. P.; Zamolodchikov, B. I.; Zaplatin, N. L.; Kol'ga, V. V.; Polikanov, S. M.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1968. 42p. (In Russian). Dep.

The physical investigations are reviewed, which were carried out using the monoenergetic beams p, d, $^3$He, $^4$He, $^6$Li at a maximum proton energy 60 MeV and the intensity being 100 $\mu$A. A variant of the isochronous sector cyclotron with a small spread ($10^{-4}$) in the accelerated particle beam, has been considered. Continuous variation of the particle energy in the ratio 1 : 4 is also possible. A tentative scheme of the extracted beams lay-out and further analysis in energy is given. (auth)

**46570** (JINR-P9-3969) MEASUREMENT OF THE OPTIMAL FREQUENCY-AMPLITUDE CHARACTERISTIC OF THE 680 MeV SYNCHROCYCLOTRON. Enchevich, I. B.; Tomilina, T. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 14p. (In Russian). Dep.

A method is suggested to determine the optimal frequency-amplitude characteristic of the synchrocyclotron high-frequency system without breaking the vacuum. The characteristic is read from the going accelerator, so all the factors, which affect the accelerator operation, are taken into account. As such an optimal amplitude, from the point of view of energy consumption, we consider the minimal amplitude which does not cause the decrease of the intensity of the particle beam with a maximum energy. (auth)

**46571** (JINR-P9-3970) MEASUREMENT OF THE DYNAMIC FREQUENCY-AMPLITUDE CHARACTERISTIC OF THE SYNCHROCYCLOTRON. Enchevich, I. B.; Tomilina, T. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 22p. (In Russian). Dep.

The results are given of the measurements of the dynamical frequency–amplitude characteristic of the 680 MeV synchrocyclotron high-frequency system depending on the time. The technique described gives the possibility to control the dynamical characteristic and to fix it quickly, with the accuracy sufficient for practical aims (in the frequency ±0.025%, in the amplitude of the accelerating voltage ±8.5%, and in the time intervals ±0.06%). Besides, this technique allows to obtain a number of characteristics such as: the frequency of the ion capture into the process of acceleration, the frequency of the proton extraction. It became possible to determine the effect of the beam loading on the resonance system and to obtain some data for determination of the amplitudes of the betatron and radial-phase vibrations, which, at all, cannot be measured in static regime. (auth)

**46572** (JINR-P16-3936) EFFICIENCY OF INTRODUCING ADDITIONAL BORON INTO THE SHIELDING FROM THE ACCELERATOR STRAY RADIATION. Zaitsev, L. N.; Kimel, L. R.; Komochkov, M. M.; Sidorin, V. P.; Sychev, B. S.; Ulitin, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1968. 8p. (In Russian). Dep.

The efficiency of introducing additional boron into the concrete shielding for the accelerator stray radiation has been investigated experimentally for two cases: one, using a boron-containing coating on the surface of the shielding and the second, introducing boron into the shielding, the amount being 15 kg/m$^3$. It is found that the introduction of the 40 cm of concrete, containing boron, into the first layers of the shielding decreases the dose rate of the capture $\gamma$-radiation approximately ten times as compared to that in the shielding made of ordinary concrete. (auth)

**46573** (LA-tr-68-37) POLARIZED SOURCES. Beurtey, R. (European Organization for Nuclear Research, Geneva (Switzerland)). Translation of a French report. 15p. Dep. CFSTI.

Recent developments in polarized ion sources are described. Topics discussed include charge exchangers for producing high-intensity beams, spin exchangers, and the acceleration of polarized deuterons in synchrotrons. (W.H.K.)

**46574** (NAL-10-2040) ELECTRON RING ACCELERATORS. Smith, Lloyd (National Accelerator Lab., Batavia, Ill.). Apr. 17, 1968. Contract AT(49-8)-3000. 15p. Dep. CFSTI.

Electron ring accelerator is the name adopted for the device in which ions are trapped within an intense ring of relativistic electrons and accelerated by the self-field of the electrons as the ring is accelerated in the axial direction by externally applied fields. Since the ions are constrained to move at the same axial speed, it would appear possible to achieve very high ion energies for a modest increase in electron energy. A survey of the basic principles of the device, a summary of work accomplished thus far, and an outline of plans for the immediate future are presented. In particular, an experimental program has been started at the Lawrence Radiation Laboratory to investigate the feasibility of the idea; a similar program has been under way at Dubna for some years. (auth)

**46575** (SLAC-89) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1–March 31, 1968. (Stanford Linear Accelerator Center, Calif.). July 1968. Contracts AT(04-3)-400; AT(04-3)-515. 49p. Dep. CFSTI.

The developments and operation of the Stanford Linear Accelerator during January 1, 1968 to March 31, 1968 are discussed. A summary of accelerator operations include the following: operating hours, beam intensity, klystron experience, bubble chambers, data analysis, computer operations, and special operating features such as positrons, rf separator, 82-inch bubble chamber, beam knockout, power supplies, and scheduled shutdowns. Other topics discussed were accelerator developments, research area developments, research division developments, accelerator engineering, klystron studies, and plant engineering. (B.G.D.)

**46576** (TID-24655) MEASUREMENTS AND TESTS ON MAGNETS OF THE ZGS FACILITY. Praeg, Walter F. (Argonne National Lab., Ill.). May 14, 1968. 24p. Dep. CFSTI.

For regulation and ripple studies of dc magnets, the unit step time constant and the 60 Hz and 360 Hz impedance values have been measured for magnets used with the ZGS and in its experimental areas. The measuring circuits are described and the results are summarized. In addition, test methods which detect the presence of shorted turns in magnet assemblies and which find the location of a short between turns of a coil are described. It is suggested that the unit step time constant values be put on the nameplates of the magnets in order that the regulator of each power supply can be set for the correct time constant. (auth)

**46577** (TID-24666, pp 106-7) STABILITY OF ELECTRON BEAMS WITH VELOCITY SHEAR. Briggs, R. J.; Rome, J. A. (Massachusetts Inst. of Tech., Cambridge).

Two necessary conditions for instability for electron beams focused by infinite magnetic fields are derived. (M.O.W.)

**46578** (UCRL-18103) SYMPOSIUM ON ELECTRON RING ACCELERATORS HELD AT LAWRENCE RADIATION LABORATORY, 1968. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1968. Contract W-7405-eng-48. 523p. (CONF-680210). Dep. CFSTI.

Separate abstracts were prepared for fifty-nine of the sixty papers presented at the conference. One paper was previously included in NSA as 22: 22491. Separate abstracts were also prepared for each of the three translations of preprints which were included in proceedings as pertinent references. (B.G.D.)

*For abstracts of individual papers see: 46579–46640.*

**46579** (UCRL-18103, pp 3-4) PROSPECTS AND PRESENT STATUS OF THE HIPAC. Levy, Richard H. (Avco-Everett Research Lab., Everett, Mass.).

A list of references pertinent to the prospects and present status of HIPAC is presented. (B.G.D.)

**46580** (UCRL-18103, pp 6-10) SOME PRELIMINARY THOUGHTS ON ION DRAG ACCELERATORS. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River, Ont.).

The ion drag process of acceleration is briefly discussed. Topics include Bennett pinch phenomenon for preventing the spreading of electrons, energy transfer from electron to ions, current limits, introduction of axial magnetic fields, and a brief comparison of ion-drag and electron-ring accelerators. (B.G.D.)

**46581** (UCRL-18103, pp 11-33) THE ELECTRON RING ACCELERATOR: GENERAL CONCEPTS AND PRESENT STATE OF THEORETICAL UNDERSTANDING. Sessler, A. M. (Lawrence Radiation Lab., Berkeley, Calif.).

The general concepts of a large number of phenomena associated with the electron-ring accelerator, from experimental and theoretical analysis, are discussed. Topics include compression phase, extraction process, kinematics of expansion, limit on rate

of expansion, synchrotron radiation, ionization processes, stripping of heavy elements, beam loading or cavity radiation, Touschek effect, incoherent space charge limit, self focusing, curvature effects, image field focusing, tearing effect of acceleration, negative mass instability, empirical comparison between ERA and Astron, coherent radiation instability (compressor), coherent radiation instability (accelerating column), two-stream instability (azimuthal ion–electron oscillations), two-stream instability (transverse), transverse instabilities, and transverse ring stability in uniform field. (B.G.D.)

**46582** (UCRL–18103, pp 34-43) RADIO FREQUENCY ACCELERATION OF ELECTRON RINGS. Voelker, F. (Lawrence Radiation Lab., Berkeley, Calif.).

The economics and technical aspects of rf acceleration of electron rings are discussed. (B.G.D.)

**46583** (UCRL–18103, pp 44-64) PULSED LINE ACCELERATION OF ELECTRON RINGS. Hartwig, E. C. (Lawrence Radiation Lab., Berkeley, Calif.).

The pulsed line method of accelerating electron rings by a travelling wave with an axial electric field produced by properly synchronized pulses applied to cavities is described. (B.G.D.)

**46584** (UCRL–18103, pp 65-78) ELECTRON RING ACCELERATOR: ENGINEERING CONSIDERATIONS. Salsig, W. W. (Lawrence Radiation Lab., Berkeley, Calif.).

Two types of apparatus are discussed. First, the experimental test apparatus for forming and compressing an electron ring is considered. Next, an example model of an rf accelerating column of significant energy is examined. Preliminary cost estimates are included. (B.G.D.)

**46585** (UCRL–18103, pp 79-88) EXPERIMENTAL USE. Keefe, Denis (Lawrence Radiation Lab., Berkeley, Calif.).

The characteristics of a 70-GeV proton electron-ring accelerator are discussed. These include time structure, beam emittance, and energy spread. The use of a stretching ring, in which the beam can be debunched and spread out roughly uniform in time, for physics experiments is examined. Physics experiments without the use of the stretching ring are also examined. (B.G.D.)

**46586** (UCRL–18103, pp 89-100) THE LRL MODEL PROGRAM. Peterson, J. M. (Lawrence Radiation Lab., Berkeley, Calif.).

A model of an electron-ring accelerator used to understand the new concepts and mechanism involved, is described. It is the function of the model to form a ring of about $10^{13}$ electrons and to compress it to the point where it can hold an interesting number of protons, or possibly heavy ions. If this is successful both expansion acceleration and electric acceleration of the electron ring would be attempted. (B.G.D.)

**46587** (UCRL–18103, pp 101-5) REPORT OF THE WORKING GROUP ON INJECTORS. Lamb, W. A. S. (Lawrence Radiation Lab., Berkeley, Calif.).

Various technical aspects of beam injection in an electron-ring accelerator are discussed. These are number of electrons per pulse, energy required, transverse phase area, energy spread, and pulse length. A summary of the injector requirements and a description of two-existing accelerators which closely meet the requirements are described. A short- and long-range development program is briefly summarized. (B.G.D.)

**46588** (UCRL–18103, pp 106-10) REPORT OF THE WORKING GROUP ON THE COMPRESSOR UNIT AND THE MODEL PROGRAM. Mills, F. E. (Univ. of Wisconsin, Madison); Peterson, J. M.

A brief summary is presented on injection methods, vacuum and ion loading, extraction and beam transfer, and diagnostics associated with LRL electron-ring accelerator model. (B.G.D.)

**46589** (UCRL–18103, pp 111-15) JOINT REPORT OF RF AND PULSED LINE GROUPS. Blewett, John P. (Brookhaven National Lab., Upton, N. Y.); Loew, G.

Various aspects of rf and pulsed line acceleration methods in electron-ring accelerators are discussed. A comparison of both these systems is included. (B.G.D.)

**46590** (UCRL–18103, pp 116-19) THEORETICAL ASPECTS. Courant, Ernest D. (Brookhaven National Lab., Upton, N. Y.); Laslett, L. Jackson.

The theoretical aspects of stability of the loaded electron ring, both in the compression and the accelerating phase, are discussed. (B.G.D.)

**46591** (UCRL–18103, pp 120-6) EXPERIMENTAL USES: IONS AND PROTONS. Kadyk, John A. (Lawrence Radiation Lab., Berkeley, Calif.).

The possible applications of the electron-ring accelerator to nuclear chemistry and high-energy physics are reviewed. (B.G.D.)

**46592** (UCRL–18103, pp 127-32) CONCLUDING REMARKS: WHERE DO WE STAND? Sands, Matthew (Stanford Linear Accelerator Center, Calif.).

Two basic questions are considered relating to the feasibility of an electron-ring accelerator for high-energy protons. These are whether such a machine can work and if such a machine can be built should it be built. (B.G.D.)

**46593** (UCRL–18103, pp 145-63) ELECTRON-RING ACCELERATOR. Keefe, D. (Lawrence Radiation Lab., Berkeley, Calif.).

The characteristics of a high-energy accelerator based on coherent field effects are described. A summary of the research at Dubna and LRL is presented with specifics on the model program at LRL. A description of an electron-ring accelerator with specifications for the injector, compressor, ring regulator, accelerator column, conventional facilities, and experimental use is included. (B.G.D.)

**46594** (UCRL–18103, pp 164-83) ACCELERATION BY THE COHERENT FIELD OF AN ELECTRON RING: PROPOSAL FOR AN ACCELERATOR DEVELOPMENT STUDY. Sessler, A. M. (Lawrence Radiation Lab., Berkeley, Calif.).

Some technical sections from the draft document, with some modifications and corrections, are presented. These include a general description of the accelerator, proposed research program, parameters, injection process, compression process, expansion and acceleration process, rf accelerating structure, incoherent space charge limit, longitudinal instabilities, transverse instabilities, ionization processes, and synchrotron radiation. (B.G.D.)

**46595** (UCRL–18103, pp 184-5) SOME USEFUL PARAMETERS. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.).

Some useful parameters based on that given in ERAN-1 with some additions and minor corrections are presented. The parameters are given for electron-ring accelerators during beam injection and the compressed phase. (B.G.D.)

**46596** (UCRL–18103, pp 186-90) RATHER DIFFERENT SET OF PARAMETERS. Sessler, A. M. (Lawrence Radiation Lab., Berkeley, Calif.).

A change in parameters is considered which relieves the many-body phenomena and yet preserves the interesting properties of electron-ring accelerators. (B.G.D.)

**46597** (UCRL–18103, pp 191-4) PARAMETERS, PARAMETERS, PARAMETERS. Sessler, A. M. (Lawrence Radiation Lab., Berkeley, Calif.).

Various parameters for electron-ring accelerators are presented. (B.G.D.)

**46598** (UCRL–18103, pp 195-206a) (DM-92) PRELIMINARY COMPARISON OF ION DRAG ACCELERATOR PROPOSALS. APPENDIX A. ION DRAG ACCELERATION BY FALL-OFF OF MAGNETIC FIELD WITH REFERENCE TO THE ELECTRON RING OF THE ACFER PROPOSAL. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.).

Various aspects of ion-drag acceleration by fall-off of the magnetic field are discussed. Topics include basic terminology and conservation relations, relation of $\gamma_z$ ($\gamma = 1/\sqrt{1-\beta^2}$ and $z$ denotes parallel to beam axis) and B, acceleration of ions, and Bennett Pinch. (B.G.D.)

**46599** (UCRL–18103, pp 207-9) CONCERNING A CIRCULAR ELECTRON RING ACCELERATOR. Garren, A. A. (National Accelerator Lab., Oak Brook, Ill.).

The technical aspects of accelerating electron rings containing protons in a circular machine are discussed. Topics include the use of the electric field for providing the centripetal force needed to bend ions around a circular path, size of the accelerator, superconducting solenoidal windings about the vacuum chamber, beam energy and intensity, and beam injection. (B.G.D.)

**46600** (UCRL–18103, pp 210-18) STATIC-FIELD ACCELERATION OF ELECTRON RINGS. Furth, H. P. (Princeton Univ., N. J.); Rosenbluth, M. N.

The properties of a simple axisymmetric static-field accelerator are considered and some limitations that are encountered once magnetic-moment conservation has been removed as the limiting factor are pointed out. (B.G.D.)

**46601** (UCRL–18103, pp 219-23) ACCELERATION OF POSITIVE IONS WITH A SWEPT BEAM OF ELECTRONS. Johnson, R. M. (Lawrence Radiation Lab., Berkeley, Calif.).

A method for accelerating protons or positive ions using only a swept beam of electrons in a manner similar to that used in a cathode-ray tube is described. (B.G.D.)

**46602** (UCRL-18103, pp 224-7) NOTES ON RELATIVISTIC KINEMATICS. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.).

Notes on relativistic kinematics pertinent to design of electron-ring accelerators are presented. (B.G.D.)

**46603** (UCRL-18103, pp 228-36) COMPUTATIONAL PROGRAM. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

Two types of computer programs set up for application to the electron-ring development program at LRL are described. One type of program is concerned with the question of particle handling, either concerning the fields and dynamics of compression, or with the fields one might maintain down the acceleration tube. The second type of program concerns the fields of the beam itself. Initial results from the use of these programs are outlined. (B.G.D.)

**46604** (UCRL-18103, pp 237-44) COMPUTER PROGRAMS. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

Computer programs are described for use on the LRL CDC-6600 for the solution of certain computational problems relating to the Collective Ion Accelerator. The areas treated were space charge fields including self-fields of ring and image-field coefficients for ring in a conducting tube, compression fields and dynamics, and fields from a periodic azimuthal current on the surface of a tube. (B.G.D.)

**46605** (UCRL-18103, pp 245-53) CONCERNING THE FORCE ON A CURRENT RING IN AN ELECTROMAGNETIC FIELD. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

The dynamical equations of a charged particle can be written and analyzed in any inertial frame on one's choosing. It is shown, however, by means of an example, that one must exercise restraint in attempting to transform the force on the ring as-a-whole from one such inertial frame to another. (B.G.D.)

**46606** (UCRL-18103, pp 254-62) NOTE ON THE COMPRESSOR COIL SYSTEM FOR ERA. Beal, J. W. (Lawrence Radiation Lab., Livermore, Calif.).

Some computer calculations pertaining to the compressor coil system design for a collective ion accelerator are presented. It was desired to take a preliminary look at the coil system with respect to several accelerator parameters. The computer calculation is for dc vacuum fields with no provisions for eddy currents, etc. in nearby conducting elements. (B.G.D.)

**46607** (UCRL-18103, pp 263-9a) CONCERNING THE DAMPING OF ORBIT RADIUS IN A PULSED FIELD. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

A study of the compression process, in an axially symmetric field of a pulsed coil or coil system, is presented. The principles involved in the compression process are illustrated. (B.G.D.)

**46608** (UCRL-18103, pp 270-2) CONCERNING THE DAMPING OF MINOR RADIUS FOR A TOROID DURING COMPRESSION. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

The consequences of energy spread in the particles that are injected simultaneously onto their respective circular orbits, as distinct from the damping of betatron oscillations for particles that have a common energy, are examined. (B.G.D.)

**46609** (UCRL-18103, pp 273-4) CONCERNING THE AMPLITUDES OF OSCILLATION FOR POSITIVE IONS IN THE ELECTROSTATIC FIELD OF AN ELECTRON BEAM WHOSE MINOR RADIUS b IS DAMPED (TOTAL ELECTRON CHARGE IS CONSTANT). Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

An equation for describing the amplitudes of oscillation for positive ions in the electrostatic field of an electron beam whose minor radius is damped when the total electron charge is constant is derived. (B.G.D.)

**46610** (UCRL-18103, pp 275-8) POTENTIAL WELL OF A TOROID. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

Computational results are reported for the electrostatic potential of a toroid of major radius R, minor radius b, and constant charge density $Q/2\pi^2Rb^2$ per unit volume (esu). The potential as evaluated is positive; if Q were negative, the potential would provide a potential well for positive ions. (B.G.D.)

**46611** (UCRL-18103, pp 279-90) SELF-FIELDS OF A TOROID. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

The self fields of a toroidal charge and current distribution were examined with the object of determining to what extent space-charge forces (that act on a single particle) differ from the forces calculable for a straight beam. (B.G.D.)

**46612** (UCRL-18103, pp 291-7) CONCERNING THE ELECTROSTATIC FIELD OF IONS LOADED INTO A UNIFORM ELECTRON BEAM. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

The density distribution of ions and their associated electric field are investigated when a relatively small number of ions is introduced in a uniform electron beam, such as that used to form the toroidal current of the projected Electron Ring Accelerator. (B.G.D.)

**46613** (UCRL-18103, pp 298-300) THE EFFECT OF TRAPPED IONS ON THE Q-VALUES AT INJECTION. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.).

The effect of trapped ions on the Q-values at injection is discussed. The contribution to the actual Q arising from the self field is included. (B.G.D.)

**46614** (UCRL-18103, pp. 301-3) BUILDUP OF ELECTRON OSCILLATION AMPLITUDE IN RING IF THE $Q_R = 1$ RESONANCE IS CROSSED. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.).

The presence of ions in the electron ring increases $Q_V$ and $Q_R$ where $Q_V = n^{\frac{1}{2}}$ and $Q_R = (1-n)^{\frac{1}{2}}$ and n is the field index; since $n = 0$ for transfer of the ring to the accelerating region (unless it is held in a travelling-wave field) it follows that $Q_R > 1$, so that an integral resonance needs to be passed, or $Q_R$ made >1 at injection with the aid of strong focusing. The former possibility is considered and the rate at which the resonance must be crossed if disastrous blow-up is to be avoided. If the ring is held stationary during ionization period, dQ/dt is determined by the ionization rate; alternatively if the fields are changed dQ/dt is determined by the detailed way in which the change occurs. (B.G.D.)

**46615** (UCRL-18103, pp 304-17) ON THE TOLERANCES NECESSARY TO CROSS THE $Q_R = 1$ RESONANCE. Symon, K. R. (Univ. of Wisconsin, Madison).

The radial equation of motion for an electron in a ring such as that used in electron-ring accelerators is solved near the integral resonance Q = 1. The tolerance in coil displacement is determined. It is considered whether nonlinearities may help to reduce the growth in amplitude when the resonance is crossed. (B.G.D.)

**46616** (UCRL-18103, pp 318-21) STRIPPING OF HEAVY ELEMENTS IN THE ERA. Levy, R. H. (Avco-Everett Research Lab., Everett, Mass.).

The stripping time and rate of production of heavy ions in the Electron-Ring Accelerator are calculated. (B.G.D.)

**46617** (UCRL-18103, pp 328-31) EXTRACTION OF ELECTRON RINGS BY A SEQUENCE OF AXIALLY SHIFTED COIL PAIRS. Keil, E. (European Organization for Nuclear Research, Geneva, Switzerland).

After compression in the compression chamber the electron rings want to be displaced in the axial direction to a point where they can be picked up by the rf accelerating field. A system of coils is described which achieves this aim in such a way that the axial and radial stability of the electron rings is concerned without relying on self focusing. (auth)

**46618** (UCRL-18103, pp 332-40) PULSED ACCELERATING COLUMN AND PULSED MAGNETIC FIELD FOR THE ELECTRON RING ACCELERATOR. Faltens, A.; Hartwig, E.; Hernandez, P. (Lawrence Radiation Lab., Berkeley, Calif.).

The electric field pulse for accelerating the electron ring and the magnetic field pulse for focusing the electron-ring in an Electron Ring Accelerator are discussed. Two structures which have the most desirable properties for pulsed acceleration are described. (B.G.D.)

**46619** (UCRL-18103, pp 341-3) ON LINEAR ACCELERATION. Walkinshaw, W. (Rutherford High Energy Lab., Chilton, Eng.).

The kinematics of particle motion in a linear accelerator, as might be usefully noted with respect to the acceleration of a charged macro particle such as the electron ring of the Electron-Ring Accelerator, are discussed. Most particularly, the relevance might be with respect to the lock-in behavior that is obtained when $\beta \equiv v/c$ comes quite close to unity and with respect to the tolerances that must be met during the lower-energy stages of acceleration. (B.G.D.)

**46620** (UCRL-18103, pp 344-9) REMARKS ON THE COMPRESSOR-ACCELERATOR INTERFACE. Smith, L. (National Accelerator Lab., Oak Brook, Ill.).

The synchronization problem for compression, release, and timing in electron-ring accelerators is discussed. The problem is considered for pulsed-line and rf linac accelerators. (B.G.D.)

**46621** (UCRL-18103, pp 350-62) CONCERNING THE AXIAL ACCELERATION OF ELECTRON RINGS. Morton, P. L. (Stanford Linear Accelerator Center, Calif.).

The question as to whether the longitudinal phase motion of the ring is stable if the total charge and mass of the ring differ from the values for which the accelerating structure was designed is discussed. The question of the tearing apart of electrons as well as the separation of the protons from the electrons due to rf fields is treated. (B.G.D.)

**46622** (UCRL-18103, pp 363-4) RADIATION BY A RELATIVISTIC PARTICLE PASSING THROUGH A CAVITY. Faltens, A. (Lawrence Radiation Lab., Berkeley).

The radiation emitted from and the energy loss of a relativistic charged particle passing through a cavity is discussed. An equation describing the energy loss is presented. (B.G.D.)

**46623** (UCRL-18103, pp 365-75) INTERACTION OF A RING OF CHARGE PASSING THROUGH A CYLINDRICAL RF CAVITY. Morton, P. L. (Stanford Linear Accelerator Center, Calif.); Neil, V. K.

The maximum energy that an electron ring can gain in the axial direction by means of rf cavities resonating in the lowest mode is discussed. The energy gained by the electron ring is written as $\Delta U = AQ - BQ^2$, where A and B are constants that depend on both the cavity geometry and the phase and magnitude of the accelerating field, and Q is the total charge in the ring. The constants A and B are determined. (B.G.D.)

**46624** (UCRL-18103, pp. 376-8) WHAT IS THE AXIAL EXTENT OF THE RING, AND THE FIELD AVAILABLE TO ACCELERATE THE IONS? Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.).

Previously parameters for the Electron Ring Accelerator have been given assuming that the ring contracts down to a minor radius of 0.09 cm, and that the equilibrium position of the ions during acceleration is at the edge of the minor axis. Unless special measures are to be taken, both these assumptions are said to be very optimistic. Both these factors are examined. (B.G.D.)

**46625** (UCRL-18103, pp 379-82) CRITERION FOR ELECTRONS TO PULL AWAY FROM IONS WHEN CROSSING THE RF GAP. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.).

The criterion for an ion bunch to move from $r = \frac{1}{2}a$ to $r = a$ where a is radius of the electron ring as the ring crosses a rf gap is presented. (B.G.D.)

**46626** (UCRL-18103, pp 383-8) REMARKS ON THE ELECTRON-ION RING AXIAL MOTION. Pellegrini, C. (Laboratori Nazionali de Frascati, Italy).

The motion of the ring in the z (axial) direction defined by the axis of the magnetic field which extends all along the accelerating column is considered. The ring is a two component system, electrons and ions, on which are acting external forces due to either electric fields or to a gradient in the axial magnetic field. In addition there are the internal forces which are treated only in linear approximation. (B.G.D.)

**46627** (UCRL-18103, pp 389-400) ORBIT EQUATION WITH TORSION. Teng, Lee C. (National Accelerator Lab., Oak Brook, Ill.).

Differential equations are developed for particle motion about a curve with torsion. (B.G.D.)

**46628** (UCRL-18103, pp 401-18) INCOHERENT RING IMAGE IN A CIRCULAR CYLINDER: ANALYSIS AND PROPOSED COMPUTATIONAL PROGRAM. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

Equations were derived for analysis of an incoherent ring image in a circular cylinder. The computer program RIMIC (Ring Image, Incoherent) investigating the image fields, with ac boundary conditions applied to magnetic field at the tube walls was proposed. (B.G.D.)

**46629** (UCRL-18103, pp 419-25) INCOHERENT RING IMAGE IN A CIRCULAR CYLINDER: RESULTS. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

The results of an investigation of the relevant image fields, with ac boundary conditions applied to the magnetic field at the tube walls, using the RIMIC program are presented. (B.G.D.)

**46630** (UCRL-18103, pp 426-30) ENHANCEMENT OF INCOHERENT RING-IMAGE FOCUSING THROUGH USE OF DIELECTRIC. Laslett, L. Jackson (Lawrence Radiation Lab., Berkeley, Calif.).

The use of a thin dielectric layer at the surface of the accelerating tube in an electron-ring accelerator to achieve single-particle axial stability for an unneutralized beam is discussed. (B.G.D.)

**46631** (UCRL-18103, pp 431) TOUSCHEK PHENOMENON IN THE ERA. Sessler, A. M. (Lawrence Radiation Lab., Berkeley, Calif.).

The transfer rate from transverse to longitudinal energy is evaluated. (B.G.D.)

**46632** (UCRL-18103, pp 432-3) EMPIRICAL COMPARISONS OF THE ERA WITH OBSERVATIONS OF RF IN THE ASTRON. Briggs, R. J. (Lawrence Radiation Lab., Livermore, Calif. Massachusetts Inst. of Tech., Cambridge).

In the normal mode of beam injection in the Astron, an instability is observed during the first few microseconds for injected currents greater than the order of 10-20 A. The question of how one might guess about the stability of the Electron-Ring Accelerator on the basis of the Astron observations is examined. (B.G.D.)

**46633** (UCRL-18103, pp 434-41) COHERENT RADIATIVE INSTABILITIES OF THE COMPRESSED ELECTRON RING. Briggs, R. J. (Lawrence Radiation Lab., Livermore, Calif. Massachusetts Inst. of Tech., Cambridge).

The azimuthal stability of an electron ring situated in a circular pipe of infinite length is considered. It is concluded that if the pipe radius is large enough for a mode synchronous with the beam to propagate, that the coupling of the beam with this mode can lead to a potentially dangerous instability. The first section has the conditions to propagate, the second has the field analysis (g-factor calculation), and the third section discusses growth rates and stability conditions for various cases and the order of magnitude of the reduction rate from a developed instability. (auth)

**46634** (UCRL-18103, pp 442-5) EFFECT OF COHERENT RADIATION DURING RING COMPRESSION. Pellegrini, Claudio (Laboratori Nazionali de Frascati, Italy); Sessler, A. M.

Several parameters are evaluated and mathematical descriptions are presented for describing the effect of coherent radiation during ring compression in electron-ring accelerators. (B.G.D.)

**46635** (UCRL-18103, pp 446-7) RESOLUTION OF AN APPARENT DISCREPANCY BETWEEN THE RESULTS OF IVANOV AND BRIGGS-NEIL. Neil, V. K. (Lawrence Radiation Lab., Livermore, Calif.).

The work of Ivanov on influence of shielding on the negative mass effect and the results of Briggs and Neil on negative mass instability in a cylindrical layer of relativistic electrons are examined. (B.G.D.)

**46636** (UCRL-18103, pp 448-56) MUTUAL OSCILLATIONS OF IONS AND ELECTRONS IN THE ERA. Mills, F. E. (Univ. of Wisconsin, Madison).

The forces exerted on the electrons and ions in an electron-ring accelerator from the image field, with emphasis on the restoring force which is centered on the local $\theta$ position of the beam, are discussed. (B.G.D.)

**46637** (UCRL-18103, pp 457-66) NOTES ON THE INTERACTION OF ELECTRON RING WITH IONS. Fowler, T. K. (Lawrence Radiation Lab., Livermore, Calif.).

Brief notes are presented describing the interaction of electron-rings with ions in electron-ring accelerators. (B.G.D.)

**46638** (UCRL-18103, pp 467-83) INFLUENCE OF SHIELDING ON THE NEGATIVE-MASS EFFECT. Ivanov, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR).

An abstract was previously prepared from the original language and appears in NSA as 22: 5038. (B.G.D.)

**46639** (UCRL-18103, pp 484-500) STABILITY OF A RING CURRENT IN A CYLINDRICAL CAVITY. Ivanov, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR).

An abstract was previously prepared from the original language and appears in NSA as 22: 5036. (B.G.D.)

**46640** (UCRL-18103, pp 501-22) THE STABILITY OF A CYLINDRICAL LAYER OF ELECTRONS, SURROUNDED BY A METAL SHIELD, IN A UNIFORM MAGNETIC FIELD. Ivanov, I. N.; Makhan'kov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR).

An abstract was previously prepared from the original language and appears in NSA as 22: 5037. (B.G.D.)

**46641** (UCRL-18382) SUPERCONDUCTING MAGNETS FOR THE 200-GeV ACCELERATOR EXPERIMENTAL AREAS. Meu-

ser, Robert B. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 9p. Dep. CFSTI.

The decision whether to use conventional or superconducting magnets for beam transport in the first of the 200-GeV accelerator experimental areas must be made by late 1969. The practicability and economics of the superconducting magnet system to aid in making that decision is studied. A major part of the program is to build a beam line containing several superconducting bending and quadrupole magnets. Magnet requirements, magnet design and material selection, and the refrigeration system design are discussed. (auth)

**46642** (UCRL-Trans-1370) INFLUENCE OF SHIELDING ON THE NEGATIVE-MASS EFFECT. Ivanov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated by Benjamin Thayne for Univ. of California, Lawrence Radiation Lab., Berkeley, from report JINR-P9-3476-2. 18p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 22: 5038. (W.H.K.)

**46643** THE THEORY OF THE FOCUSING OF IONIC RAYS BY A HOMOGENEOUS MAGNETIC FIELD WHOSE SHARPLY DEFINED BOUNDARIES ARE CIRCULAR LINES. II. Bogomolov, E. A.; Saulit, V. R. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 52-74(Feb. 1968). (In Russian).

The theory of the focusing of charged particles by a homogeneous magnetic field whose boundaries are circles was discussed. The effect of the fringing field on the focusing is taken into consideration. The first-, second- and third-order focusing conditions are given and the expressions for second-, third-order and full transverse aberrations of the image point are evaluated. Formulas for dispersion were obtained. (auth)

**46644** FOCUSING OF A RELATIVISTIC ELECTRON FLOW. Hsieh, H. C.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 39: 4199-4205(Aug. 1968).

The trajectory differential equation governing the motion of relativistic electrons is derived in terms of the scalar and vector potentials of the system using the principle of least action. The conservation of energy and momentum are used to develop the paraxial-ray differential equation describing the beam radius of a laminar-flow relativistic electron beam. The focusing of the electron beam in drift and accelerating regions has been examined and the conditions for perfect balancing and nonspreading of a laminar-flow drifting beam are also derived. It is shown that the equilibrium condition for Brillouin flow is that $2\omega_L^2 - \omega_p^2[1 - (u_z/c)^2] = 0$, where $\omega_L$ is the Larmor precession frequency and $\omega_p$ the electron-plasma frequency. $u_z$ and c denote, respectively, the axial beam velocity and the speed of light in vacuum. The variation of the normalized ripple amplitude and the scallop wavelength of a drifting beam is discussed. The profile of a beam accelerated in a uniform longitudinal electrostatic field is also illustrated. (auth)

**46645** A SPUTTERING-TYPE PENNING DISCHARGE FOR METALLIC IONS. Gavin, B. F. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 64: 73-6(Sept. 1, 1968).

The production of beams of metallic ions from a cold cathode type Penning discharge has been proposed for use with the Hilac and Omnitron. With the aid of a unique sputtering electrode, significant amounts of low charge state metallic ions have been analyzed and measured. (auth)

**46646** CALCULATION OF THE MINOR COMPONENTS OF A MAGNETIC FIELD. Highland, V. L.; Macek, R. J. (Temple Univ., Philadelphia. Univ. of Pennsylvania, Philadelphia). Nucl. Instrum. Methods, 64: 69-72(Sept. 1, 1968).

Using functions suggested by a simple model of a magnet, the measured values of its main component are fitted, and the values of the minor components are predicted. The method is accurate and computationally simple. It should be useful in computing the fields of large aperture magnets with large fringing fields now used in particle physics. (auth)

**46647** REMOTE CONTROLLED SLITS FOR THE MSU CYCLOTRON EXTERNAL BEAM SYSTEM. Benenson, W.; Deforest, R.; Johnson, W. P.; Kashy, E. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 64: 40-4(Sept. 1, 1968).

Circuitry and mechanical designs are described for the remotely-operated water-cooled slit jaws on the MSU cyclotron external beam line. The displacement of the slit jaw from the center of the beam line is automatically set on the reading of the fifteen-turn helipot on the console of the cyclotron. The setting accuracy and reproducibility is ±0.05 mm. (auth)

**46648** LONGITUDINAL COULOMB REPULSION OF IONS IN LINEAR ACCELERATOR IN THE CASE OF THE MAXIMUM VALUE OF THE BEAM PHASE SPACE DENSITY. Kapchinskii, I. M. At. Energ. (USSR), 25: 104-7(1968). (In Russian).

The degeneration feature of the potential hole of longitudinal oscillations is considered for the case of the maximum increase of the two-dimensional beam phase space density on the plane phase — longitudinal momentum. It is proved that the maximum size of the momentum trapping region has a zero limit, but the phase width of the trapping region remain finitely. A stationary phase space distribution is considered. The distribution is uniformly inside the separatrix and has a zero value outside of it. (auth)

**46649** COHERENT SYNCHROTRON OSCILLATIONS IN THE PRESENCE OF SPACE CHARGE. Lebedev, A. N. At. Energ. (USSR), 25: 100-4(1968). (In Russian).

A general dispersion equation is derived which determines a coherent synchrotron oscillation spectrum in the presence of external rf field and cluster of space charges. The existence of instability of certain modes in a high intensity bunch is proved in the case when there is a resonant element in a chamber. In a non-resonant chamber all modes are stable providing that the equilibrium distribution decreases from the center of the bunch to its periphery. Otherwise certain modes can be unstable. (auth)

**46650** CALCULATION OF THE ENVELOPE OF THE TRAJECTORY OF PARTICLES IN THE STRONG FOCUSING ACCELERATOR WITH STRAIGHT SECTIONS. Lembra, Yu.; Kyiva, P. (Tartu State Univ.). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 17: 181-4(1968). (In Russian).

The matrix method is used for simplifying the calculation technique of the envelope of the trajectory of particles in a strong focusing accelerator with straight sections. Equality of equilibrium orbit radii and magnetic field indices in focusing and defocusing sectors and lengths of straight sections is not assumed in this description. Results are given for the focusing sector, first straight section, defocusing sector, and second straight section. (auth)

**46651** ISOCHRONOUS CYCLOTRON WITH AXIALLY SYMMETRIC ELECTRIC AND MAGNETIC FIELDS. Takeda, Tatsuoki; Arikawa, Tatsuo (Tokyo Univ.). Jap. J. Appl. Phys., 7: 1105-13(Sept. 1968).

An electron model of an axially symmetric isochronous cyclotron was constructed and the beam properties were investigated for the purpose of studying, experimentally, an accelerator using electric and magnetic fields in combination as a guide field. As a model cyclotron of those which accelerate proton beams up to ~100 MeV, a maximum energy of electrons of 50 keV ($\gamma \cong 1.1$) was chosen. The isochronous field of the cyclotron was composed of electric and magnetic fields — the electric field having a radial component and the magnetic field having an axial component on the median plane. The electric field was produced by concentrically divided electrodes set on the inside walls of the dees; the magnetic field was produced by using a pair of air-core coils. Electron beams were accelerated up to almost maximum energy. The behavior of the electron beam was in good agreement with computer calculations. (auth)

**46652** BEAM CURRENT REGULATOR. Sheen, E. M.; Glass, W. A.; Ratcliffe, C. A. (Battelle-Northwest, Richland, Wash.). Rev. Sci. Instrum., 39: 1263-5(Sept. 1968).

To improve the average current stability of the positive ion beam from a Van de Graaff type accelerator, a feedback regulator is described that stabilizes the beam current by controlling the portion of the beam removed by a linear-sweep deflection system. The deflection system is linear on both axes to provide a uniform current density over the face of the target. The error signal for the feedback system is derived from a measurement of the target current. Beam currents as small as 1 nA can be regulated to ±0.1% of a preset value. (auth)

**46653** ION BEAM ABERRATION AND DRIFT BY MARGINAL FIELDS WITH TRANSVERSE VARIANTS IN THE MAGNETIC PRISMS. Malov, A. F. Zh. Tekh. Fiz., 38: 914-21(May 1968). (In Russian).

The effect of the dispersed marginal field on the yield and the behavior of the charged-particle beam in the magnetic prism, having variations of the marginal field not only along the outgoing beam but across it, is examined. It is shown that the effect of the marginal field on the yield in the prism is equivalent to the displacement of the source to other points, the coordinates of which are calculated. Aberrations in the output, added to the laterally displaced beam, are also calculated. (tr-auth)

**46654** ELECTROSTATIC TRANSPORT WITH PERIODIC FOCUSING. Glazov, A. A.; Novikov, D. L. Zh. Tekh. Fiz., 38: 922-7(May 1968). (In Russian).

The calculation, construction, and results of the investigation of

the electrostatic transport with periodic focusing were reported. The transport was used for the transfer of electron beams with current up to 500 mamp. The transfer coefficient of the current is close to 0.9. The beam diameter at the outlet and the yields from the transfer is 10 mm. (tr-auth)

**46655** MECHANICALLY REFRIGERATED LIQUID HYDROGEN TARGET. Brooks, J. M.; Otavka, M. A. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 39: 1348-50(Sept. 1968).

A liquid hydrogen target which incorporates a mechanical refrigerator for cooling rather than using a liquid hydrogen reservoir or cold helium gas has been successfully operated at Argonne National Laboratory. Use of the mechanical refrigerator eliminates the hazard of a large liquid hydrogen inventory in the vicinity of the target. In addition, remote operation is greatly simplified over methods previously used. A commercially available 20.4 K refrigerator, standard gas handling and purifying components, and a specially constructed nonmetallic target flask comprise the mechanical portions of the target system. The target flask requires approximately 20 cc of liquid hydrogen. The system has operated satisfactorily in the external accelerated proton beam of the Zero Gradient Synchrotron. (auth)

**46656** HIGH ENERGY LINEAR ACCELERATOR APPARATUS. Giordano, S. T. (to United States Atomic Energy Commission). U. S. Patent 3,403,346. Sept. 24, 1968.

A high-energy linear accelerator apparatus for protons and heavier charged particles is described. A plurality of uniform-diameter disk-shaped irises forming periodic, alternate, long and short cells are provided; also, fixed and adjustable tuning means are provided. This structure has the advantage of high shunt impedance at increasing particle velocities, high transit time factor, small mode separation around the operating mode (e.g., $\pi/2$), low sensitivity to tank de-tuning errors, simple control, and high energy injection into cyclic particle accelerators. (auth)

**46657** SUPERCONDUCTING LINEAR ACCELERATORS. Smith, T. I. (Stanford Univ., Calif.). Advan. Cryog. Eng., 13: 102-8(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

Particles in a linear accelerator obtain energy from the electric fields produced inside microwave cavities. Because of the low rf losses in superconductors, a cryogenic accelerator can be expected to have a much greater duty cycle (unity in most cases), greater beam intensity, and better energy resolution than a conventional accelerator made of room temperature copper. Details of a five foot long superconducting accelerator which has been successfully operated at Stanford University are presented. (auth)

**46658** GOLD AND HOLE EFFECTS IN GOLD-PLATED QUANTAMETERS. Ladage, A. (Deutsches Elektronen-Synchrotron, Hamburg). pp 210-17 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

A brief review is given of the results of calibration measurements on beam monitors made at DESY. Some unexpected effects found with quantameters are also discussed. (auth)

**46659** RF LOOP MONITOR FOR THE SYNCHROTRON ELECTRON BEAM. Anderson, B.; Matin, S. M. (Harvard Univ., Cambridge, Mass.). pp 280- of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

An rf loop monitor exploiting the radiofrequency bunching of the electron beam has been developed at the CEA (Cambridge Electron Accelerator) to meet the requirements of operation with ultra-high vacuum and of increased sensitivity. This monitor is clean, compact and quite insensitive to electrical noise produced by high power pulse circuits. Several monitors with non-linear diode detector systems are operational. A synchronous detector system is under construction. Similar monitors will be used in the 270-MeV linac and the beam transport for the colliding beam facility at the CEA. Data on the performance of the monitor are presented. (auth)

**46660** PRECISION TOROIDAL CHARGE MONITOR FOR SLAC. Larson, R. S.; Horelick, D. (Stanford Univ., Calif.). pp 260-79 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Toroids have not been widely used as precision charge monitors, their accuracy in general being no better than to about 1%. Development of a resonant toroid charge measurement system was undertaken at SLAC. This would, if necessary, employ preamplifiers very close to the toroid to minimize cable pickup noise, and it would include a digital noise averaging system to achieve the highest usable sensitivity. The aim was a system accuracy of $\leq 0.1\%$ at an average beam current of 20 $\mu$A, and a useful measurement range to at least 20 nA. Attention was paid to such matters as temperature stabilization of the toroid ferrite core, and temperature control of the critical timing circuitry. Construction and installation were completed in 1966, and continuing study has led to some modifications and improvements. The system appears to meet its design requirements with excellent stability and reliability. The SLAC beam characteristics are described, the resonant toroid theory discussed, a full description of the system given, and details of the calibration system presented, together with results in the use of the system. (UK)

**46661** CAVITY AND TOROID MONITORS AT DARESBURY. Aitken, T. W. (Daresbury Nuclear Physics Lab., Eng.). pp 257-9 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

At Daresbury work on two types of fully transparent electron beam monitors is being carried out including a 3rd harmonic rf pickup cavity and a toroid pickup monitor. The rf cavity system is being used in the extracted beam line and will be used in future lines. The toroid system is in the process of development. Toroid monitors do not compete with Faraday cups for accuracy, but are useful general purpose monitors. At present the normal output electron beam from NINA consists of a 1 msec pulse containing $4 \times 10^{10}$ electrons. This represents an instantaneous beam current of about 8 $\mu$A. In order to see the fine structure during the output pulse a suitable monitor must have a rise time of ~10 $\mu$sec, a decay time of >100 msec to eliminate droop in the 1 msec pulse, and yet be capable of detecting $\mu$A currents and smaller, if possible. To make such a monitor accuracy has been sacrificed to some extent, so that an accuracy of better than 5% cannot be claimed at present, although this may be improved. (auth)

**46662** IONISATION SYSTEMS USED ON NIMROD FOR NON-DESTRUCTIVE BEAM PROFILE MEASUREMENT. Gardner, I. S. K.; Borden, A. I. (Rutherford High Energy Lab., Chilton, Eng.). pp 252-6 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

A description is given of the ionization systems used at Nimrod for the measurement of the radial and vertical beam profiles. These systems, which are similar to those on the Argonne P. S., were built to measure the beam intensity profiles in the radial and vertical planes throughout the acceleration cycle. It was hoped that these measurements would help to account for the beam lost at various points of the machine cycle, and also provide final energy beam profiles for targeting and extracted beam information. These beam losses occur during injection, during trapping, and during the first 20 milliseconds of acceleration. A brief account is given of the results obtained. (auth)

**46663** DEVICE FOR MEASUREMENT OF THE PROTON BEAM EMITTANCE. Demichouskii, D. A.; Troyanov, E. F. (Inst. of High Energy Physics, Serpukhov, USSR). pp 244-51 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The device described was developed for measurements in the proton beam in the injection channel of the 70-GeV Serpukhov proton synchrotron. A movable slit aperture and a beam catcher, in the form of several plates, are used. The measuring process is automized and takes about 15 working cycles of the PS Injector. The emittance is shown on the screen of the memory oscilloscope. The device makes it possible to measure the beam emittance at different stages of a particle pulse. (auth)

**46664** SENSITIVITY OF THE THICK-WALLED ION-CHAMBER AT BREMSSTRAHLUNG ENERGIES 4 TO 27 MeV. Gurevich, G. M.; Ponomarev, B. N.; Solodukhov, G. V. (Lebedev Inst. of Physics, Moscow). pp 238-43 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The thick-walled ion chamber seems to be the most convenient and sensitive device at $\gamma$-quantum energies less than 30 to 50 MeV. The accuracy of the chamber sensitivity calculations is limited by the inaccuracies in the data available for such parameters as the gas ionization potential, the pair-production cross-section, energy losses and ranges of the electrons and positrons, etc. The alumi-

num thick-walled chamber at the Lebedev Physical Institute is described. Results of the experimental and calculated sensitivity comparisons are given and the optimum geometrical parameters are discussed. (auth)

**46665** NONDESTRUCTIVE PROTON BEAM PROFILE SCANNERS FOR THE CPS, BASED ON THE IONISATION OF RESIDUAL GAS IN THE BEAM VACUUM CHAMBER. Johnson, C. D.; Thorndahl, L. (CERN, Geneva). pp 227-37 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Studies are described on some devices based on the collection of electrons or positive ions liberated by the proton beam from the residual gas in the beam vacuum chamber. The number of electron-ion pairs generated per unit volume is proportional to the proton density in a given region of the beam, and fast collection of these electrons or ions can provide a convenient means of beam observation, including width and intensity and shape of the proton distribution. For use on the strong-focusing synchrotron it is considered that a strip electrode system, combined with a focusing magnetic field for electrons along the direction of the electric field, could provide a device having a spatial resolution of 1 or 2 mm. In order to cover the whole horizontal aperture of the CPS, however, 40 to 80 strips will be required. In order to avoid development of a multiplexer system, the aim is to collect the electrons from the residual gas by some form of scanning system. Methods tried include electrostatic deflection of the ionization electrons across a slit detector, using plane parallel electrodes, and a separate accelerating field; a similar technique in which the accelerating field is made to rotate through 90° or more at uniform angular velocity; and a crossed electric and magnetic field technique in which ionization electrons are collected along the zero electric equipotential surface, which is scanned through the proton beam. These methods are discussed. The favored device is one giving orthogonal projection, in the horizontal and vertical planes, of the proton density in the beam, with observation times of about 1 μsec and spatial resolution of 1 mm. Sensitivity and time and spatial resolutions are discussed, and descriptions are given of a rotating field scanner, and a crossed field scanner. (UK)

**46666** CRYOGENIC CALORIMETER FOR USE AS AN ABSOLUTE REFERENCE QUANTAMETER IN LOW INTENSITY PHOTON BEAMS. Danielsson, B.; von Dardel, G. (Univ. of Lund, Sweden). pp 222-5 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

An ideal absolute quantameter would appear to be a calorimeter of size adequate to absorb the whole shower energy. In the instrument described, cryogenic temperatures are used, at which the specific heat decreases as $T^3$ below the Debye temperature. At liquid He temperature the specific heat of Pb is reduced by a factor of 200 compared with the room temperature value. Additional advantages of working at low temperatures are a reduction of the time constant for thermal equilibrium inside the calorimeter block and of the heat flux by radiation. The construction of a prototype instrument is described. The precision in determination of absorbed power is estimated as $5 \times 10^{-4}$ K. (UK)

**46667** DESIGN AND PERFORMANCE OF A PROTOTYPE SECONDARY EMISSION QUANTAMETER FOR USE AT DARESBURY. Tait, N. R. S. (Daresbury Nuclear Physics Lab., Eng.). pp 218-21 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Machine development at Daresbury will lead to a ten-fold increase in beam intensity (present intensity is up to $2 \times 10^{11}$ equivalent quanta per sec at 4 GeV), and a prototype SEQ has been designed with this in mind. This instrument contains 17 copper shower plates each of thickness 16 mm. In order to improve secondary emission stability the copper surfaces are gold plated with a nickel undercoat. Aluminum foils are situated between the plates, and the signal is taken from these foils. Heat is removed from the shower plates by conduction into side plates with attached water-cooled pipes. Monte-Carlo calculations on cascade shower production in copper were used to calculate longitudinal shower leakage from the plates. Analytic integrations have also been performed. Under normal conditions the quantameter operates with a negative potential applied to the shower plates, and the output signal to the current integrator is the result of secondary emission from the gold surfaces. If a positive potential is applied and the integrator polarity reversed, secondary emission from the aluminum foils is registered. The quantameter output is shown plotted as a function of bias potential. The secondary emission curve is characteristic, with a significantly steeper slope for gold surfaces than aluminum surfaces. The variation of response with transverse displacement is also shown. Flatness of the response for gold surfaces is assumed due to the hole effect. Measurements were compared with those of a secondary emission monitor in a 3.5-GeV electron beam. Long term stability will be the crucial factor in successful operation. (UK)

**46668** HEAT TRANSPORT AND REFRIGERATION FOR SUPERCONDUCTING LINEAR ACCELERATORS. McAshan, M. S. (Stanford Univ., Calif.). Advan. Cryog. Eng., 13: 428-33(1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

A principal problem in the design of a superconducting accelerator is the maintenance of a suitable, uniform operating temperature over the length of the accelerator structure. Because superconductors are not perfect conductors at microwave frequencies, this problem is compounded by the production of heat at the structure surfaces. A discussion of this problem of heat transport and removal is given together with a description of the refrigeration system for the 500-foot electron linear accelerator soon to be under construction at Stanford. This installation is designed to operate at a temperature of 1.85°K with an accelerator dissipation initially of 300 watts and eventually of several thousand watts over the 500-foot length. (auth)

**46669** AUTOMATIC EVACUATION PLANT. Otto, G.; Mende, A. (Karl-Marx-Univ., Leipzig). Mes.-Steuern-Regeln, 11: No. 6, 99-102(June 1968).

A high-vacuum installation for evacuating the ion tube of the 2-MeV Van de Graaff generator is described. The evacuating process is fully automated including fail-safe protection and complete pump shutdown in case of emergency. Final pressures of the order of $10^{-6}$ torr are reached. The operation is monitored by optical and acoustic signals. The construction and the operation of the plant are shown. Essential components include a two-stage prevacuum pump, a three-stage high-vacuum pump, a two-stage cooler set, several magnetically and motor actuated valves, two Pirani vacuum meters, a high-vacuum meter and an ionization vacuum meter, and a temperature measuring device, and a switchboard. The high-vacuum pump is designed to maintain the $10^{-6}$ torr pressure level continuously. (JPRS)

**46670** CALCULATION OF PUMPING SYSTEMS FOR LINEAR ACCELERATORS. Croitoru, P. (Institut de Physique Atomique, Bucharest). Vide, 23: 151-61(May-June 1968). (In French).

Various types of vacuum systems for linear accelerators are considered including pumping through the supply guide, pumping through the terminal cells provided with evacuating apertures, and pumping through units distributed along the whole section. (W.H.K.)

**46671** SYMPOSIUM ON BEAM INTENSITY MEASUREMENT, DARESBURY, 22-26 APRIL 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968. 312p. (DNPL/R-1; CONF-680427).

Separate abstracts were prepared for the 31 papers presented. (W.H.K.)

*For abstracts of individual papers see: 46658–46667 and 46672–46692.*

**46672** BEAM MONITORING AT ORSAY. Grossetete, B.; Isabelle, D. B. (Ecole Normale Superieure, Orsay, France). pp 3-19 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The various systems which have been used on the Orsay 1.3-GeV linac to monitor electron and photon beams are described. An outline of the machine is given and most of the monitors in present use are indicated. These can be divided into two classes, depending on the purpose for which they are used. Some are needed by the machine operator to follow the machine operations permanently. Along the main beam line only induction monitors and rf cavities can be used. The rf cavities are beam position sensors. For measuring cross-sections, high accuracy monitors are used. The only absolute monitor is the Faraday cup, in which all the charged particles are collected. Most of the time, however, it is impossible to use it as a direct monitor and relative monitors calibrated against the Faraday cup are used. They must be thin enough to avoid any large perturbation of the main electron beam. For this reason either ionization chambers which saturate at relatively low intensity but are very sensitive, or secondary emission monitors whose response is linear over a wide range of intensities, are employed. A non-intercepting induction monitor may be necessary for special experiments. A brief description of

the secondary emission quantameter used to monitor the γ-ray beam is included. (auth)

**46673** BEAM MONITORING FOR THE GLASGOW LINEAR ACCELERATOR. Land, D. V. (Univ. of Glasgow). pp 20-30 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

A short description is given of the accelerator and beam handling installations. Important characteristics of electron and positron beams are detailed. The inductive beam current and position monitoring systems, their performance and problems encountered in their design, and the performance of the television beam profile viewing system, are described. Beam monitoring for particular classes of experiments is briefly discussed. (auth)

**46674** BEAM MONITORING AT CORNELL. De Wire, J. W. (Cornell Univ., Ithaca, N. Y.). pp 31-5 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Reliance has been placed on the quantameter at Cornell as the basic standard, with the use of secondary emission monitors to cope with the problems of saturation and temperature effects with increase of accelerator intensities. The work of Chin-Fatt (1964) on saturation effects using He-isobutane, $H_2-CH_4$ and $He-N_2$ is reviewed and discussed in relation to present problems. It is pointed out that even with lighter gas mixtures ionization quantameters cannot be used at present beam intensities without serious recombination effects, and there is also the problem of the temperature dependence of the calibration constant. A secondary emission quantameter is under construction, together with a smaller secondary emission monitor. These will be calibrated in a bremsstrahlung beam against a mercury calorimeter. Constructional details are given. A precision Faraday cup has been designed for absolute calibration of the monitors with electrons. (UK)

**46675** PRINCETON-PENNSYLVANIA BEAM MEASUREMENT. Kirchgessner, J. L.; Kang, C. L.; Henness, J. (Princeton-Pennsylvania Accelerator, N. J.). pp 36-42 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The PPA is a rapid cycling (20 Hz) 3-GeV proton synchrotron. The present beam intensity level is $\sim 4 \times 10^{10}$ protons per pulse or $8.0 \times 10^{12}$ protons/sec, corresponding to a peak beam current of 24 mA circulating. During the first 5 years of operation all beam intensity and position measurements were made with standard induction electrodes, which proved marginally satisfactory, except for rf pickup into the broad band monitoring system. With the realization of a slow extracted proton beam this was too intense for satisfactory use of ionization chambers and much too weak for standard induction electrode techniques. Qualitative information was obtained with phosphor-TV systems. Other techniques used were sample radioactivation and beam-on-target telescopes. It was realized that a good monitoring system could be built which took advantage of the following beam properties: the beam is tightly bunched since the rf remains on during the extraction process, and there is <1% frequency modulation during the 10 msec extraction time over the top of the magnet cycle. This system was based on a tuned cavity with feedback to control the beam spill duty factor, and is fully described. While an ionization chamber was unsatisfactory for obtaining an accurate beam current vs time signal, use was made of an IC in obtaining fast beam position information on the extracted proton beam, and an oscilloscope display was obtained. A similar arrangement was also employed in the synchrotron ring to serve as a monitor on the circulating beam current just prior to start of extraction or internal spill. An extraction efficiency meter was also developed. (UK)

**46676** MEASUREMENT OF THE CIRCULATING PROTON INTENSITY OF THE ARGONNE ZGS. Martin, R. L. (Argonne National Lab., Ill.). pp 43-8 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The standard technique employed is measurement of the charge induced on an aluminum mesh electrode in the ring. The method of calibration of this electrode is described in detail. Final calibration was accomplished in a full-scale model of a straight section vacuum chamber using the beam from an electron gun operating at 10 to 60 keV. The present calibration is $3.72 \times 10^{-12}$ V per proton. The detection circuitry is described. Resonances in the electrode occur at 95 and 125 MHz, and require filters in the circuitry. Calibration of the fast-Q system is inconsequential as it is used only to observe the rf bunch structure. Additional confidence in these calibrations was afforded by measurements of pion production and extraction efficiency. Foil activation techniques are being developed for use in the circulating beam in connection with radiochemical studies, and are discussed. Alignment of foils on the target is critical, since the beam moves to the target very slowly and penetration is not large. In general, foil activations indicate fewer protons than the Q system. (UK)

**46677** DIAGNOSTIC EQUIPMENT IN HIGH-ENERGY BEAM LINES. Redgrave, R. L. (Rutherford High Energy Lab., Chilton, Eng.). pp 49-57 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The first extracted proton beam at the Rutherford Laboratory was initially brought to a focus in the magnet room, and an ionization chamber was installed at that point. The beam line was later extended and ionization and secondary emission chambers were placed at the target station. Much of the early development work on these monitors was carried out in these positions. The present beam line layout is shown. There are two extracted proton beam lines with monitors at the target stations and magnet room focus point. (auth)

**46678** BEAM INTENSITY MONITORING AT THE CERN PROTON SYNCHROTRON. Agoritsas, V.; Battisti, S.; Johnson, C. D. (CERN, Geneva). pp 58-67 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

A brief description is given of the development of beam monitoring techniques at CERN, and new techniques and data are described in detail with a view to giving an idea of the present and future possibilities. Topics covered include beam characteristics, beam intensity monitoring, calibration of beam intensity monitors, electronics of measurement, charge emitting plates and targets, indirect beam intensity monitors (target monitors), current transformers for ejected beam, and future trends. (UK)

**46679** NEUTRINO BEAM MONITORING. Wachsmuth, H. (CERN, Geneva). pp 68-74 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

One of the problems in the interpretation of neutrino experiments is insufficient knowledge of the energy spectrum of neutrinos traversing the neutrino detector. The small signal from neutrinos (1 interaction from $4 \times 10^{12}$ neutrinos traversing 1 $m^3$ liquid propane) implies indirect methods to determine and monitor the neutrino spectrum. The latest version of the CERN neutrino beam and its monitoring is briefly described. (auth)

**46680** STUDIES FOR A HIGH-POWER FARADAY CUP. Isabelle, D. B.; Jeanjean, M. (Univ., Paris, Orsay, France). pp 97-8 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The direct beam power of the Orsay linac will be increased from 2 kW to 12 kW in the near future (maximum energy 2.1 GeV, repetition rate 150 pps, peak current ~35 mA), and the problem of designing a high power Faraday cup is being investigated. The design of an HPFC depends very much on the energy of the incident electrons. If the heat conductance of the stopping block material is low (such as in Pb) the temperature rise will depend on the energy loss distribution over the beam cross section. For lower energy electrons (~100 MeV) the beam is easily spread over a large area by multiple scattering in foils in front of the HPFC, but for high energy electrons (>1 GeV) multiple scattering is negligible and the use of an electromagnetic lens becomes necessary. In order to avoid excessive heating of the block in which the cascade is developed, water cooling is necessary. Problems connected with the use of water cooling and their influence on HPFC efficiency are discussed. Such cooling could be avoided if an HPFC could be designed that would accept high power beams over short time periods. Use of a copper core in which the main body of the electron shower is developed may be promising. Some measurements are described on the temperature behavior of a Faraday cup employing lead stacks, lead blocks, and copper blocks. (UK)

**46681** DARESBURY FARADAY CUP. Hatton, V. W. (Daresbury Nuclear Physics Lab., Eng.). pp 99-104 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hat-

ton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Some aspects of the design of the NINA Faraday cup are described, and a brief summary of the experimental results to date is given. (auth)

**46682** COMPARISON OF CEA AND SLAC FARADAY CUPS BY MEANS OF A SECONDARY EMISSION MONITOR. Dell, G. F.; Fotino, M. (Harvard Univ., Cambridge, Mass.). pp 105-16 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The Faraday cup is considered as the standard for direct calibration of charged particle monitors and for indirect calibration of photon monitors at the CEA and SLAC installations, and the comparison described is based on data from a 24 hour run at SLAC and data accumulated over more than 1 year at CEA. The choice of secondary emission monitors as satisfactory intermediate monitors for intercalibration purposes was determined by the very good stability and reproducibility over long periods, independence of response to pulse length or repetition rate, and ease of transportation. Constructional and operational features of the SEM employed are described. The electron beam runs at CEA and SLAC had as nearly as possible identical geometries and dimensions. The beam run characteristics are tabulated, and the structures of the Faraday cups are illustrated. Care was taken to give the monitor the same positioning in both beams. At CEA the Faraday cup was shielded; at SLAC it was unshielded. Pressures were of the order of $10^{-7}$ to $10^{-6}$ torr during the measurements. Most measurements for intercalibration purposes were made at 3 GeV. It was found that, for the experimental geometry used, the responses of the Faraday cups agreed to within 0.4% at 3 GeV. (UK)

**46683** SECONDARY EMISSION CHAMBERS FOR MONITORING THE CPS EJECTED BEAMS. Agoritsas, V. (CERN, Geneva). pp 117-51 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Since the slow ejection technique was successfully tested a great need for reliable, nondestructive and continuous beam intensity monitors has existed. The circulating protons of the CERN Proton Synchrotron (CPS) can be ejected by two different methods, fast ejection and slow ejection. The properties and characteristics of the CPS ejected beams are summarized in tabular form and the general layout of the ejected proton beams around the CPS is shown. The time structure of the fast and slow ejected beams is shown graphically. The problem was to monitor the high-intensity, high-energy proton beams. One of the monitoring methods suggested for the CPS slow ejected beams is the SEC (secondary emission chamber). This technique is described in detail. (auth)

**46684** SINGLE FOIL MONITOR. Raquet, E. (Deutsches Elektronen-Synchrotron, Hamburg). pp 152-8 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Disadvantages of multi-foil secondary emission monitors are outlined. If a secondary emission assembly with single foil is used, integration of the small emitted current would be a problem, especially at low beam intensity, for example in future positron beams. Also in special cases such as analysis of the energy spectrum in front of a collimator, or providing beam-centering information, the emitted secondary current would be much too small for easy integration with commercially available integrators. Another disadvantage in measuring the emission current by integration is the low time resolution caused by the large time constant on the integration circuit. In order to couple the advantage of the linear response of the secondary emission with the high sensitivity and fast time resolution of secondary electron multiplier tubes, a reference monitor device was designed which is described and illustrated. Two types of multipliers have been used, one being a well known type with curved dynodes and the other being a new focused mesh multiplier with flat dynodes. Beam profiles were measured by counting the secondary electrons emitted from single foil strips across the beam spot. (UK)

**46685** INTENSITY MEASUREMENTS OF EXTRACTED ELECTRON BEAM FROM THE TOKYO 1.3-GeV ELECTRON SYNCHROTRON AND CALIBRATION OF A SECONDARY EMISSION MONITOR. Sasaki, H. (Tokyo Univ.). pp 159-65 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

An electron beam has recently been extracted from the 1.3-GeV electron synchrotron and has become available for experiments in elementary particle physics. In order to measure the intensity of the extracted electron beam a secondary emission monitor was constructed and calibrated. The calibration of the monitor was performed with a Wilson-type quantameter and with a thick-walled ionization chamber separately. Details are given of the SEM, together with the calibration procedure. (auth)

**46686** METHOD OF STABILISING HIGH CURRENT SECONDARY EMISSION MONITORS. Garwin, E. L.; Dean, N. (Stanford Univ., Calif.). pp 166-8 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Attempts have been made to construct SEMs exhibiting stability in electron beams of current density in the range 1 to 40 $\mu A/cm^2$. A SEM made at the Stanford Linear Accelerator Center, from extensions of Orsay suggestions, is described, and efficiency variation with transmitted beam is shown graphically. The efficiency change was about 20% for a transmitted charge of ~0.16 coulomb with a beam of area ~0.08 $cm^2$. Efficiency increases with transmitted charge. Gold was used for coating the foils on account of its stability against oxidation. Gold, however, sorbs CO, which is a main constituent of the residual gas in UHV systems. When the electron beam desorbs the CO, lowering the surface concentration below equilibrium, the work function decreases, and the secondary emission coefficient is increased. The problem of achieving stability in a SEM is to find a foil coating material which does not sorb CO; silver meets this requirement but is not stable against oxidation. Variation of efficiency with transmitted beam for a 3-foil SEM employing silver is shown graphically. A significant rise in efficiency was observed up to $24 \times 10^{16}$ electrons transmitted, and a major change of efficiency was observed when the beam was steered over the face of the stationary SEM. This is understood in terms of the sorption characteristics of the oxide surface on the silver-coated foils. When the oxide was removed by Ar-ion sputter, the variation of efficiency was less than 1% for $25 \times 10^{16}$ to $100 \times 10^{16}$ electrons transmitted on a beam area of 0.08 $cm^2$, and the effect of steering was very small. (UK)

**46687** USE OF QUANTAMETERS OF VARIOUS TYPES FOR MEASUREMENT OF TOTAL BREMSSTRAHLUNG BEAM ENERGY. Kruglov, S. P.; Lopatin, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). pp 169-81 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The quantameter is the most commonly used device for measurements of total bremsstrahlung energy. Its operation is based on the transition curve method, which relates the total energy of a photon beam and the transition curve integral (Blocher et al., Phys. Rev., 79: 419(1950)). In applying this method it is usual to measure the ionization at various depths in an absorber, plot curves, and integrate graphically. In the quatameter, however, integration is automatic, the collected ionization charge being proportional to the curve area. A correlation is obtained between the collected charge and the total beam energy. Transition curves in copper for bremsstrahlung beams with various peak energies are shown. The principle of operation of a quantameter is analyzed mathematically, and the instrument is shown to be a multiple ionization chamber. In the well known Wilson type quantameter the integration is done by Simpson's rule. Some experiments conducted with this type of quantameter are briefly outlined, and its sensitivity is discussed. The sensitivity was found to fall slightly when the peak energy decreased from 100 to 10 MeV. Application of the Gaussian quadrature formula is discussed with regard to integration, and construction of a Gauss-quantameter is shown, together with sensitivity measurements. The instrument can also be used for energy measurements in electron beams. (UK)

**46688** QUANTAMETER CALIBRATION AND PERFORMANCE AT DESY. Raquet, E. (Deutsches Elektronen-Synchrotron, Hamburg). pp 182-6 of Symposium on Beam Intensity Measurement, Daresbury, 22-26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Quantameters with a gas mixture of 95% Ar/5% $CO_2$ were used at DESY until 1967; this mixture was found satisfactory with regard to linearity of quantameter response. The intensity of collimated $\gamma$-beams did not exceed a 1 to $3 \times 10^8$ effective quanta per pulse for a pulse length of 500 $\mu$sec to 1 msec, and in this intensity range response was fairly independent of beam intensity. The intensity of the beams can now, however, be improved and with a new linear accelerator as booster the intensity will increase by an order of magnitude; this may involve serious quantameter saturation effects and recombination problems. In order to pre-

pare for this higher intensity, experiments have been conducted with various other gas fillings, such as He + $N_2$ and pure $H_2$, using a secondary emission monitor as reference, calibrated against a Faraday cup, and comparisons made with Ar + $CO_2$ instruments. Graphs are shown indicating the dependence of the specific quantameter gain on number of incident electrons. For He + $N_2$ a linear response up to ~$6 \times 10^8$ electrons per pulse was found, with an upper limit at 6 to $7 \times 10^9$, a factor of ~30 increase compared with Ar + $CO_2$. Ion collection plateaus were flat for high intensities. For pure $H_2$ a response loss of <0.5% was found up to the measured limit of $7 \times 10^9$ electrons per pulse, and the plateaus were long and flat. The long term stability of the quantameter is briefly discussed, particularly with regard to gas leakage; only metal seals were used. (UK)

**46689** QUANTAMETER FOR THE BONN 2.5-GeV ELECTRON SYNCHROTRON. Stein, H.; Wedemeyer, R.; Weisse, E. (Univ., Bonn). pp 187-93 of Symposium on Beam Intensity Measurement, Daresbury, 22–26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The quantameter described must be cooled because of a power up to 80 W in the bremsstrahlung beam, and it should allow measurements of the effectiveness of the radial and longitudinal correction gaps. The instrument has 12 copper plates forming a cylinder of radius 8.3 and length 12.3 $X_0$, and the gas used is Ar + 5% $CO_2$. The copper plates are grounded. Ionization chambers between the copper plates are defined by two additional aluminum plates of thickness 0.3 mm, serving as high voltage and collector plates. Radial correction is performed by a cylindrical condenser surrounding the copper block. The radial and longitudinal corrections are discussed, together with their measurement. The only task of the radial corrections is to keep the sensitivity independent of the radial position of the beam, that is, to maximize the central area of flat response. The quantameter was calibrated with a Faraday cup at 1.1 and 1.8 GeV, and behavior at low energies compared with a Wilson quantameter. A mean value of $4.75 \times 10^{18}$ MeV/coulomb was obtained for the calibration constant. A steep increase of the constant was observed at low energies. A model to explain this behavior is presented. The energy dependence of the constant for a monoenergetic beam and a bremsstrahlung beam was calculated. Thin layers of other metals (for example gold) covering the copper plates give rise to changes, including an energy dependence of sensitivity. (UK)

**46690** CALIBRATION AND PERFORMANCE OF CEA QUANTAMETERS. Dell, G. F.; Fotino, M. (Harvard Univ., Cambridge, Mass.). pp 194-207 of Symposium on Beam Intensity Measurement, Daresbury, 22–26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

The high energy photon beams used for experimental purposes at the Cambridge Electron Accelerator are monitored with Wilson-type gas filled quantameters. The photon-induced shower is developed and absorbed in 18 unplated 1 cm thick copper disks, and the configuration ensures linearity of response throughout the energy range at CEA. Gas mixtures employed are 94% Ar/6% $CO_2$ and 90% He/10% $N_2$, the former mainly for intercalibration with other laboratories, and the latter for reducing saturation and recombination processes. In order to reduce undesirable intensity-dependent saturation effects observed with standard quantameters the construction of one instrument was modified to reduce plate gap. In addition to gas-filled quantameters two other units, one with unplated disks and the other with gold plated disks, were evacuated for use as non-saturable secondary emission quantameters. Details are given of calibration and performance. (UK)

**46691** INTERCALIBRATION OF THE FRASCATI QUANTAMETERS WITH MONITORS OF OTHER LABORATORIES. Murtas, G. P. (CNEN, Frascati, Italy). pp 208-9 of Symposium on Beam Intensity Measurement, Daresbury, 22–26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

Quantameters of the Wilson type have been in operation for some years at the Frascati 1-GeV electron synchrotron for $\gamma$ and electron beam total energy measurements. The contained gas is 95% Ar/5% $CO_2$, and the average gap between the first eleven electrolytic Cu plates is 1.50 mm. The estimated value of $K_Q$ is $4.79 \times 10^{18}$ MeV/coulomb. The collected charge is measured by a current integrator with an error of ~0.5%, and the total beam energy is measured within 2 to 3%, while the relative response is within ~1%. Comparisons were made with the $S_2$ Cornell quantameter, and data obtained were in good agreement. A comparison was also made with a DESY secondary emission monitor. (UK)

**46692** HIGH-PRECISION FARADAY CUP AND QUANTAMETER FOR SLAC. Yount, D. (Stanford Univ., Calif.). pp 75-96 of Symposium on Beam Intensity Measurement, Daresbury, 22–26 April 1968. Hatton, V. W. (ed.). Daresbury, Eng., Daresbury Nuclear Physics Lab., 1968.

See DNPL/R-1; CONF-680427.

A review of the work done prior to January 1967 on the SLAC Faraday cup and quantameter and a summary of the more recent test data obtained with other monitors, including a secondary emission monitor, a calorimeter, and a toroid are presented. The comparisons of beam monitor response for positrons and electrons are of particular interest. The new data are generally consistent with those published earlier; in particular, they support the previous estimate of the absolute Faraday cup efficiency (100.0 ± 0.2)% at energies from a few hundred MeV up to 15 GeV. (auth)

# PHYSICS (NUCLEAR)

## Neutron Interactions with Matter

*Refer also to abstracts 46055, 46215, 46280, 46301, 46748, and 46749.*

**46693** (ANL–7416) ARGONNE CODE CENTER: BENCHMARK PROBLEM BOOK. NUMERICAL DETERMINATION OF THE SPACE, TIME, ANGLE, OR ENERGY DISTRIBUTION OF PARTICLES IN AN ASSEMBLY. (Argonne National Lab., Ill.). Feb. 1968. Contract W-31-109-eng-38. 73p. Dep. CFSTI.

The Benchmark Problem Book is intended to serve as a sourcebook of solutions to mathematically well-defined problems for which either analytical or very accurate approximate solutions are known. This initial collection contains benchmark problems relating to numerical determination of the space, time, angle, or energy distributions of particles in an assembly. (D.C.W.)

**46694** (APDA–219) ETOE: A PROGRAM FOR ENDF/B TO MC$^2$ DATA CONVERSION. Green, D. M.; Pitterle, T. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1968. Contract AT(11-1)-865. 50p. (ENDF–120). Dep. CFSTI.

The computer program ETOE for preparing a MC$^2$ cross section library tape from an ENDF/B tape is described. The mathematical formulation is outlined, and flow charts and a sample problem are given. The program is written in FORTRAN IV for the CDC 3600. (J.W.R.)

**46695** (EURFNR–537) TABLES OF EVALUATED NEUTRON CROSS SECTIONS FOR FAST REACTOR MATERIALS. Langner, I.; Schmidt, J. J.; Woll, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jan. 1968. 663p. (KFK–750; EUR–3715; EANDC(E)–88-U). Work Performed under United States–Euratom Fast Reactor Exchange Program.

Tables of evaluated data, as functions of incident neutron energy, are presented for the neutron cross sections and resonance parameters of materials that are of particular interest in the design of fast and intermediate reactors. The materials covered include C, Cr, He, H, Fe, Mo, Ni, O, $^{239}$Pu, Na, $^{235}$U, and $^{238}$U. (D.C.W.)

**46696** (FEI–103) GENERAL CONSIDERATION OF CERTAIN QUESTIONS OF THE KINETICS OF A NEUTRON FLUX IN NONMULTIPLYING AND MULTIPLYING MEDIA WITH USE OF THE HIGHER HARMONICS. Pupko, V. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 114p. (In Russian). Dep.

Equations of the kinetics of neutrons for multiplying and nonmultiplying media are derived which consider the higher harmonics of neutron flux. The method described is used to obtain a precise solution for equations for the flux and importance of neutrons in a bare intermediate reactor in age-diffusion approximation. (J.W.R.)

**46697** (IN–1199) SCATTERING LAW FOR LIQUID SODIUM AT SMALL MOMENTUM TRANSFERS. Randolph, P. D. (Idaho Nuclear Corp., Idaho Falls). July 1968. Contract AT(10-1)-1230. 21p. Dep. CFSTI.

The thermal neutron scattering law for liquid sodium at 102°C has been measured for the momentum transfer range $\hbar\kappa$ of $0.3 \lesssim \kappa \lesssim 1.5$ Å$^{-1}$ for energy transfers out to 0.032 eV. These measurements extend earlier scattering law measurements to the region of small momentum transfer where incoherent scattering predominates. The measurements were made at small scattering angles (3° to 18°) in an evacuated flight path at incident energies of 30 and 51 MeV. The scattering law results are presented combined with the older measurements. Agreement is good except at small energy transfers where resolution effects are important. Analysis of the quasi-elastic incoherent peaks gives a Debye-Waller coefficient of 0.22 Å$^2$. A width analysis of the peaks indicates that liquid sodium acts like a solid for times $\gtrsim 1.5 \times 10^{-12}$ sec. (auth)

**46698** (TID–24489) CINDA 68: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut. ENEA Neutron Data Compilation Centre, Gif-Sur-Yvette (France). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Unit). June 1968. 1026p. DTIE Free.

A bibliographic guide to experimental and theoretical information on neutron cross sections, resonance parameters, thermal scattering laws, fission parameters, and other related quantities is presented. A one-line format includes the element, isotope, or compound studied; the quantity studied; the type of investigation; the type of reference; the incident neutron energy range; the complete reference for the document; the laboratory at which the work was performed; and brief comments on the methods used and the results obtained in the investigation. (D.C.W.)

**46699** ON THE MEASUREMENT OF RELATIVE THERMAL NEUTRON/FAST NEUTRON RATIO IN AN INSTALLATION OF THE TYPE FOR ACTIVATION ANALYSIS. Weber, G.; Cuypers, M. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 37: 55-63(1968). (In French).

In 14-MeV neutron activation analysis, the irradiations are made in shielding configuration which differ often from one laboratory to the other. In this study an attempt was made to show how the thermal neutron flux, resulting from the degradation of 14-MeV neutrons, varies for several irradiation systems. The method of indium foil activation was used. The influence of the target cooling system on the flux ratio was determined. (auth)

**46700** THEORETICAL AND EXPERIMENTAL STUDY OF NEUTRON WAVE PROPAGATION IN MODERATING MEDIA. Booth, Ray Sturgis. Gainesville, Fla., Univ. of Florida, 1965. 194p.

Thesis.

The space-, energy-, and time-, or frequency-dependent Boltzmann equation in the diffusion approximation was used within the framework of neutron thermalization theory to predict thermal neutron wave propagation in a moderating medium. This theory was then compared with the experiment conducted on a graphite pile. In the theoretical section the energy dependence was expanded in the space-energy eigenfunctions of the Boltzmann operator, and the transverse-space dependence was expanded in the orthogonal solutions to the Helmholtz equation with homogeneous boundary conditions. It was then shown that each of these space and energy modes thus formed propagate with characteristic complex inverse relaxation lengths. The perturbation method developed by Perez was used to expand these complex eigenvalues in a Maclaurin's series of the frequency variable. In cases where this series did not rapidly converge a direct solution of the complex secular determinant was obtained. Two scattering kernels were selected for implementation into the theory, the MASSMK kernel and the SUMMIT kernel based primarily upon derivations by Parks. The numerical calculations of the theory were performed on an IBM 709 digital computer and founded upon the previous work of Ohanian. In the experimental section an accurate technique for conducting neutron wave experiments in multiplying or diffusing media was presented along with the results of graphite experiment. The excitation of neutron waves, both by modulated and pulsed sources, and the electronic systems associated with their detection were discussed. Special attention was given to the analysis of data for which several computer codes were developed. In the comparison of theory and experiment it was shown that the neutron wave technique allows for the separation of diffusion and thermalization effects, thereby yielding a more exacting comparison of theoretical and experimental results. Polynomial fits of functions formed from the experimental results yielded coefficients to be compared with the theoretically derived terms of the perturbation expansion. The results of the thermal pulse propagation experiment were also analyzed by a method suggested by Moore, and confirmation of his predictions was established. The diffusion and thermalization parameters determined from the data analysis were then compared with results of several die-away experiments and with the theory. The complementary relations between the neutron wave and die-away experiments were also presented. The diffusion and thermalization parameters determined in this work for graphite of density 1.60 gm/cm$^3$ were $v\Sigma_a$ = 91 ± 1 sec$^{-1}$, vD = 2.16 ± 0.1 × 10$^5$ cm$^2$sec$^{-1}$, C = 39 ± 2 × 10$^5$ cm$^4$ sec$^{-1}$, F = 12 ± 2 × 10$^7$ cm$^6$ sec$^{-1}$. (Disser. Abstr.)

**46701** SELF-RECTIFIED POSITIVE ION ACCELERATOR AND NEUTRON GENERATOR. Carr, Barney J.; Carr, Elizabeth H. (to Kaman Corp.). U. S. Patent 3,393,316. July 16, 1968. Filed Apr. 23, 1964.

Apparatus for generating neutrons comprising an elongated cylindrical envelope defining a sealed chamber confining a gaseous hydrogen isotope under low pressure is described. The chamber contains an ion source, a target axially spaced from said source adapted to include a substance which reacts with impinging ions to produce neutrons, means for selectively releasing an isotope of hydrogen within the chamber, accelerator means for accelerating and directing ions from said source to said target,

means for applying an alternating current potential to said ion source for the production of ions and between said ion source and said target to accelerate ions into neutron producing collision with said target, and means maintaining said target at ground potential during neutron generation. (U. S. Pat. Gazette)

**46702** SOLUTION OF THE TWO-GROUP NEUTRON TRANSPORT EQUATION. II. Metcalf, D. R.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 33: 318-26(1968).

Particular numerical methods are described for solving the two-group neutron transport equations obtained in a companion paper. Numerical solutions are presented for the Milne problem and the constant source problem, and the results are compared with $P_1$, $P_3$, and double $P_1$ calculations. The most interesting result is the occurrence of a resonance in the continuum expansion coefficient which appears to be due to a zero of the dispersion function $\Omega(z)$ in the unphysical Riemann sheet. (auth)

**46703** RESONANCE ABSORPTION IN A LUMP SURROUNDED BY A HOMOGENEOUS MEDIUM CONTAINING THE SAME RESONANCE ABSORBER. Tiren, L. I. (Aktiebolaget Atomenergie, Studsvik, Sweden). Nucl. Sci. Eng., 33: 348-50(1968).

An analytical formula is derived for the effective resonance integral of a shielded sample in terms of standard expressions used in resonance integral calculations. (J.W.R.)

**46704** NUMERICAL SOLUTIONS OF BOUNDARY VALUE PROBLEMS. Lucey, J. W.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 33: 327-35(1968).

The Stabilized March Technique (SMT) is extended to the numerical solution of second-order, inhomogeneous problems, i.e., the multigroup neutron diffusion equations in one space dimension, and the one-velocity neutron transport equation in one space dimension. In the SMT, the solution vector is expanded in a complete set of vectors which is used in an unstable difference equation. The error growth is controlled, however, by periodic matrix transformations and may be preset. The method has its greatest advantage in relation to the computational speed of conventional methods in elongated meshes, such as multigroup diffusion calculations, or low-order discrete ordinate or $P_N$ calculations with many spatial mesh points. (auth)

**46705** MULTIGROUP TREATMENT OF NEUTRON TRANSPORT IN PLANE GEOMETRY. Yoshimura, T.; Katsuragi, S. (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 33: 297-302(1968).

The eigensolutions of the multigroup neutron transport equation for the isotropic scattering medium in plane geometry are found by developing Case's method. The solution of the adjoint equation is also given in an explicit form. The completeness of the eigensolutions is proved by using the orthogonality relation to the adjoint solution. The degeneracy for the continuous eigenvalue is expressed in two ways: the unit vector system and the eigenvector system. In the latter case the orthogonality is formed, and the eigenvector system is thought of as a proper normal mode. As an application of this method, the infinite medium Green's function is constructed. (auth)

**46706** QUANTUM-MECHANICAL FOUNDATIONS OF THE NEUTRON TRANSPORT THEORY. Jauho, P.; Riska, D. O. (Technical Univ. of Helsinki). Nucl. Sci. Eng., 33: 303-6(1968).

A discussion is presented of the quantum-mechanical derivation of the Boltzmann equation, along with a demonstration that use of the superlattice representation of McIrvine and Overhauser enables avoidance of singular and non-physical terms in the Hamiltonian of the neutron-moderator system. The formal validity of the Boltzmann equation in finite systems is analyzed, and it is shown that the transport description is physically meaningful for systems of dimensions $\gg 10^{-4}$ cm. (auth)

**46707** SOLUTION OF THE TWO-GROUP NEUTRON TRANSPORT EQUATION. I. Metcalf, D. R.; Zweifel, P. F. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 33: 307-17(1968).

The two-group one-dimensional neutron transport equation with isotropic scattering is studied. No analytical solution is found, but the equations are cast in a form that is convenient for numerical computation. This computation involves the solution of two coupled singular integral equations. The explicit form of these equations is obtained for two half-space problems — the Milne problem and the constant isotropic source problem. (auth)

**46708** EXPERIMENTAL DETERMINATION OF THE TEMPERATURE AND YIELD OF THERMAL NEUTRONS FROM AN ANNULAR SOURCE. Vasil'ev, R. D.; Dorofeev, G. A.; Petrov, V. I. Izmer. Tekh., No. 8, 74-5(Aug. 1968). (In Russian).

A method is suggested for determining the yield of thermal neutrons from an annular source on a graphite prism. Tabulated data are given of measurements for 15 and 20 cm annular moderators with fast neutron $\alpha$-Be-sources placed in the center. (tr-auth)

**46709** DETERMINATION OF THE MOST-PROBABLE WAVELENGTH OF NEUTRONS AND THE ANGULAR SHIFT BY ROTATION OF THE DIFFRACTING CRYSTAL. Akin, Erol. College Park, Md., Univ. of Maryland, 1967. 94p.

Thesis.

A one centimeter square cross sectional collimated neutron beam from the East Beam Port of the University of Maryland Nuclear Reactor was diffracted from the (200) planes of a sodium chloride (NaCl) single crystal (a = b = c = 5.623 Å) with the crystal stationary and while rotating with speeds of 1500, 2500, and 3500 rpm. The most-probable wavelength of neutrons was $\lambda_p = 1.265$ Å units corresponding to the $2\theta_p$ at the neutron counter angle position. The clockwise and counter clockwise rotation of the sodium chloride diffracting crystal yield the 0.16, 0.32, and 0.48° angular shift for the 1500, 2500, and 3500 rpm angular velocities, respectively. These angular shifts are the differences at the neutron counter angular position at the maximum of the neutron distribution from the stationary diffracting crystal case. The maximum of the neutron distribution for the stationary diffracting crystal case was obtained at $2\theta_p = 26.0°$ neutron counter angular position. (Disser. Abstr.)

**46710** COMPUTER CODE ABSTRACT [TWIGL]. Yasinsky, J. B.; Natelson, M.; Hageman, L. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 33: 355(1968).

TWIGL solves the two-dimensional, two-group, space-time neutron diffusion equations in rectangular or cylindrical geometry in the presence of temperature feedback. The neutron diffusion and delayed precursor equations are differenced in both space and time. The thermal-hydraulic description is based on a no-boiling, one-pass model formulated in terms of regionwise-averaged coolant and fuel metal temperature. (J.W.R.)

## Nuclear Properties and Reactions, A≤ 5

*Refer also to abstracts 46695 and 46729.*

**46711** (BMwF-FBK-68-16) ELASTIC SCATTERING OF 52-MeV DEUTERONS. Hinterberger, F. (Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik). Feb. 22, 1968. 83p. (In German). Dep.

The elastic scattering of 52-MeV deuterons was studied on 27 target nuclei from hydrogen to uranium. The measured angular distributions are analyzed in terms of the optical model. The deuteron optical-model parameters of the nuclei with $A \geq 12$ are discussed with respect to the dependence upon the energy E, the charge Z, and the mass A, to the information about nuclear structure, and to the results in distorted-wave Born approximation (DWBA) analyses. In the case of $^1$H (d,d) $^1$H, $^3$He (d,d) $^3$He, and $^4$He (d,d) $^4$He, the differential cross sections at backward angles can be understood as a superposition of a shape-elastic and a nucleon transfer process. (auth)

**46712** (LNF-68/27) ELASTIC ELECTRON SCATTERING FROM LIGHT NUCLEI AND NUCLEON–NUCLEON CORRELATIONS. Note No. 399. Malecki, A.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). May 24, 1966. 19p. Dep.

A method is presented which avoids previous difficulties (as the summation of troublesome series in the Jastrow method is now automatically performed) for elastic electron scattering from light nuclei. This allows one to perform reliable calculations for nuclei heavier than helium-4. The method is presented where the short-range correlations corrections to the elastic form factor are calculated for nuclei with nucleons in the first s- and p-shells. Numerical results are given for the helium-4 nucleus. A good fit to the experimental data is obtained by a modification of the Gaussian wave function that describes the relative motion of two nucleons in helium-4. This modification consists of obtaining a repulsive core between nucleons at short relative distances and assuming that the internucleon forces at large distances are more attractive than implied by the Gaussian model. (J.F.P.)

**46713** (NP-17576) POLARIZATION MEASUREMENT OF THE D + D PROTONS. Werren, David Wilhelm (Groningen Rijksuniversiteit (Netherlands)). 1968. 98p. Dep.

Thesis.

Polarization measurements were made of the D + D protons from the reaction D(d,p). For deuteron energies of 200 to 600 keV and a reaction angle of 53° polarization was smaller than in the

mirror reaction D(d,n)$^3$He. Values obtained agreed qualitatively with those predicted using the Blin–Stoyle formula. (J.W.R.)

**46714** STUDY OF d–$^4$He ELASTIC SCATTERING BY THE METHOD OF RESONANCE GROUPS. Laskar, W.; Le Maitre, R. (Faculte des Sciences, Nantes, France). J. Phys. (Paris), 29: 409-18(May-June 1968). (In French).

The elastic scattering d-$^4$He was studied for energies $E_d$(Lab) = 0.2, 0.933, 1.053, 1.073, 1.093, 3 and 10.3 MeV of the incident deuteron. The potential used is a two-body central interaction with exchange dependence and gaussian shape. Serber, WMBH and Biel types of exchange were investigated. Numerical results were obtained; and agreement was found in the shape and order of magnitude for angular distributions, and also the resonance for l = 2 and $E_d$(Lab) = 1.07 MeV corresponding to the first excited level of $^6$Li (J = 3$^+$, T = 0) at 2.19 MeV. (auth)

# Nuclear Properties and Reactions, 6≤A≤19

*Refer also to abstracts 45093, 46462, 46695, 46711, 46712, and 46852.*

**46715** (ANL-Trans-657) ANGULAR DISTRIBUTION OF THE RECOIL NUCLEI IN THE REACTION $^{12}$C (p, pn) $^{11}$C. Denisov, F. P.; Milovanov, V. P.; Pokrovskii, V. N.; Cherenkov, P. A.; Yutlandov, I. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by Elmar K. Wilip (Argonne National Lab., Ill.). 5p. Dep. CFSTI.

The angular distribution of recoil nuclei in the reaction $^{12}$C(p,pn)$^{11}$C was measured at a proton energy of 660 MeV. The targets used possessed a thickness of ~5.5 mg/cm$^2$ and 100 μg/cm$^2$. The measured distribution is practically the same in both cases and exhibits a tendency toward a maximum at θ = 75° (lab. system of coordinates). (auth)

**46716** (BMwF-FBK-68-06) STUDY OF THE THREE-PARTICLE DECOMPOSITIONS $^{14}$N(α,αp)$^{13}$C AND $^{14}$N(α,αd)$^{12}$C AT A PRIMARY ENERGY $E_\alpha$ = 22.89 MeV. Kuhlmann, W. R. (Cologne Univ. (West Germany). Institut fuer Kernphysik). Mar. 1968. 74p. (In German). Dep.

The three-particle reactions $^{14}$N(α,αp)$^{13}$C and $^{14}$N(α,αd)$^{12}$C were studied at an incident energy of $E_\alpha$ = 22.89 MeV by measuring α–p and α–d coincidence spectra. One detector (p,d) was fixed at θ = 25°, while the angle of the α detector was moved in the scattering plane. The following three-particle reactions were observed: $^{14}$N(α,αp)$^{13}$C(O), $^{14}$N(α,αp)$^{13}$C*(3.09 MeV and 3.68 or/and 3.85 MeV), $^{14}$N(α,αd)$^{12}$C(O). They are sequential decays via the nuclei $^{14}$N* and $^{17}$O*($^{14}$N(α,αp)$^{13}$C(O)) and $^6$Li*, $^{14}$N*, and $^{16}$O*($^{14}$N(α,αd)$^{12}$C(O)); in these nuclei there are only a few levels excited. In some cases angular correlations could be measured. (auth)

**46717** (CEA-R-3428) STUDY OF THE REACTIONS $^6$Li(pα)$^3$He, $^6$Li(dα)$^4$He, $^6$Li(dp$_0$)$^7$Li AND $^6$Li(dp$_1$)$^7$Li FROM 300 keV TO 1000 keV. Bertrand, Francoise; Grenier, Gerard; Pornet, Jacqueline (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Apr. 1968. 24p. (In French). Dep.

Experimental results are presented for the four reactions $^6$Li(p,α)$^3$He, $^6$Li(d,α)$^4$He, $^6$Li(d,p$_0$)$^7$Li and $^6$Li(d,p$_1$)$^7$Li* between 300 and 1000 keV. The angular distributions, the excitation curves, and the total cross-section curves are presented in absolute values. (auth)

**46718** (ISS-68/17) ELASTIC AND QUASIFREE ELECTRON SCATTERING FROM $^{12}$C AND PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Boffi, S.; Bounten, M.; Ciofi degli Atti, C.; Sawicki, J. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). May 20, 1968. 19p. Dep.

Projected Hartree-Fock wave functions are obtained for $^{12}$C and $^{11}$B using Volkov's force. The elastic electron scattering form factor and the angular and energy distributions for the high-energy $^{12}$C(e,e'p) reaction are calculated. While a good agreement is obtained with the observed elastic form factor, only a slight improvement over previous shell-model results is obtained for the quasifree scattering data. The relatively large deformation of the Hartree-Fock field has only a negligible effect on the calculated form factors. (auth)

**46719** WEAK-COUPLING WIDTH OF 1p HOLES TO THE GROUND STATE OF $^{20}$Ne. Wong, S. S. M. (Univ. of Rochester, N. Y. Univ. of Alberta, Edmonton). Nucl. Phys., A116: 609-16 (1968).

The validity of considering some of the states in oxygen and fluorine isotopes as 1p hole physical states weakly coupled to the ground state of $^{20}$Ne is investigated from the point of view of the width of the particle-hole interaction. The ground state wave function of $^{20}$Ne is calculated with a realistic effective interaction in the (sd)$^4$ space, and the 1p hole states are calculated with a set of best fit p-shell interaction matrix elements. The particle-hole interaction is assumed to be a central force with a Rosenfeld exchange mixture and strength adjusted to fit the data. In general, it is found that the size of the width increases with the number of holes. (auth)

**46720** MEASUREMENT OF THE DIFFERENTIAL EFFECTIVE CROSS SECTION OF THE REACTION $^{16}$O(n α)$^{13}$C IN THE ENERGY REGION FROM 14.8 TO 18.8 MeV. Sick, I.; Baumgartner, E.; Huber, P.; Stammbach, Th. (Univ., Basel). Helv. Phys. Acta, 41: 573-90(Aug. 15, 1968). (In German).

The differential cross sections of the reactions $^{16}$O(n,α$_0$)$^{13}$C and $^{16}$O(n,α$_{123}$)$^{13}$C* were measured at 28 neutron energies between 14.8 and 18.8 MeV with 60-keV energy spread for angles between 0 and 156°. Above 16.2 MeV, where the reaction proceeds via a direct mechanism, the α$_0$ cross section agrees with angular distributions calculated with Butler theory. (auth)

**46721** THE REACTION $^{14}$N(n,α)$^{11}$B WITH 14.1-MeV NEUTRONS. Bachinger, R.; Uhl, M. (Institut fuer Radiumforschung und Kernphysik, Vienna). Nucl. Phys., A116: 673-81(1968). (In German).

The reaction $^{14}$N(n,α)$^{11}$B was studied with 14.1-MeV neutrons using nuclear emulsions. The groups of α-particles leading to the ground state and the first excited state of $^{11}$B could be resolved; the groups to the levels at 4.46 and 5.03 MeV were not clearly resolved. The angular distributions present evidence for a strong contribution of direct reactions. The α-particles show a pronounced peak in the forward direction; the α-emission to the first excited state has a backward peak as well. (auth)

**46722** RESCATTERING EFFECTS IN REACTIONS WITH THREE PARTICLES IN THE FINAL STATE. Valkovic, V.; Joseph, C.; Niler, A.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys., A116: 497-515(1968).

The rescattering effect in reactions with three particles in the final state is discussed. The kinematic conditions for the observation of the contribution from the rescattering effect are given. The experimental results of the d + $^7$Li → n + α + α reaction at deuteron bombarding energies $E_d$ = 3.0, 3.2 and 5.9 MeV are presented. The experimental conditions were chosen in such a way that the neutron–alpha particle rescattering after the decay of the $^8$Be* (16.63 and 16.9 MeV states) and the $^5$He* (16.70 MeV state) could be observed. An upper limit of ≤1% has been established for the ratio of the neutron–alpha-particle rescattering contribution through an intermediate $^8$Be* or $^5$He* state to the sequential decay contribution through that state. This rescattering effect is so small that it cannot be confused with any "new" resonance levels. (auth)

**46723** RESONANCE ENERGIES AND PARTIAL WIDTHS OF QUASIMOLECULAR STATES FORMED BY THE TWO CARBON NUCLEI. Imanishi, B. (Nihon Univ., Tokyo). Phys. Lett., 27B: 267-70(Aug. 5, 1968).

The resonance energies and the partial widths are estimated by considering the compound states (or doorway states) formed by the two carbon nuclei, one of those in the first excited state and another in the ground state. (auth)

**46724** NMR OF SHORT-LIVED β-RADIOACTIVE NUCLEI BY RECOIL POLARIZATION OF NUCLEAR REACTION: MAGNETIC MOMENTS OF $^{17}$F, $^{12}$B, AND $^{12}$N. Sugimoto, Kenzo (Osaka Univ.). pp 859-70 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

Nuclear magnetic resonance experiments with short-lived β-radioactive nuclei, $^{17}$F($T_{½}$ = 66 sec), $^{12}$B($T_{½}$ = 20 msec), and $^{12}$N($T_{½}$ = 11 msec), utilizing the recoil polarization of nuclear reaction and the asymmetric β decay, are presented. The method employed to preserve the recoil polarization is discussed in some detail. In the case of $^{12}$B, observations of small relative shifts and resonance-width variations of NMR by the use of Cu, Pt, and Au metals as recoil-stopping materials are described. The magnetic moments obtained are $|\mu(^{17}\text{F}, ⅝^+)| = 4.7224 \pm 0.0012$ nm, $\mu(^{12}\text{B}, 1^+) = +1.003$ nm with an uncertainty of $10^{-3}$, and $|\mu(^{12}\text{N}, 1^+)| = 0.457$ nm with an uncertainty of several parts in $10^{-3}$. A brief discussion of comparison with nuclear theory is made. (auth)

**46725** MEASUREMENT OF THE MAGNETIC MOMENT OF $^{12}$B BY NUCLEAR SPIN PRECESSION ABOUT A WEAK FIELD. Pfeiffer, Loren; Wells, John C. Jr.; Madansky, L. (Johns Hopkins Univ., Baltimore). pp 871-7 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The nuclear magnetic moment of $^{12}B$ is obtained from a measurement of the Larmor precession frequency. Polarized $^{12}B$ nuclei are implanted in a Au or Pd lattice and caused to precess about an externally applied transverse magnetic field of a few gauss. The frequency of precession is observed by monitoring the asymmetry pattern of the decay electrons as a function of time after the application of the transverse field. The Larmor precession of $^{12}B$ was observed in Au at 8.24, 12.21, and 15.95 G, and in Pd at 15.95 G. Under the assumption that the field at the implanted nuclei is the same as the applied field, a value of (0.976 ± 0.031) nm is obtained for the $^{12}B$ magnetic moment. (auth)

**46726** HYPERFINE FIELDS OF FLUORINE IN Ni and Gd. Stokstad, R. G.; Moline, R. A.; Barnes, C. A.; Boehm, F.; Winther, A. (California Inst. of Tech., Pasadena). Contracts Nonr-220(47); AT(04-3)-63. pp 699-711 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The hyperfine magnetic fields at the sites of $^{19}F$ nuclei implanted in nickel and gadolinium were measured. Pulsed beams of $^{4}He$ and also $^{19}F$ were used to observe the time-differential precession of the 0.197-MeV, $J^{\pi} = 5/2^{+}$ level of $^{19}F$. Two hyper-fields were observed in nickel at 100°K with values $H_{hf}^{1} = +17.8 \pm 0.4$ kG and $H_{hf}^{2} = +90.2 \pm 1.4$ kG. The value for the hyperfine field for $^{19}F$ in gadolinium at 109°K was found to be $H_{hf} = +12.9 \pm 0.4$ kG. That the observed anisotropy of the time-differential $\gamma$-ray angular distribution in nickel is only about half that of the unperturbed distribution suggests that additional fields might be present to which these measurements were not sensitive. Values for the mean life and g-factor of the 0.197-MeV level were found to be 128.7 ± 1.8 nanoseconds and 1.44 ± 0.04, respectively. (auth)

**46727** THE GROUND STATE OF $^{7}Li$ AND $^{7}Be$. McClure, Walter Jackson. Tallahassee, Fla., Florida State Univ., 1967. 51p.

Thesis.

The ground state energies and wave functions of $^{7}Li$ and $^{7}Be$ and certain related energies are calculated by a variational method using cluster trial functions and realistic two-nucleon central exchange forces with repulsive core. Despite rough approximations in treating short-range correlations, fair agreement with experiment is obtained. The effect of the Coulomb force on the wave functions of these mirror nuclei is also discussed. (Disser. Abstr.)

**46728** PLANE POLARIZATION OF 170-keV $\gamma$ RAYS EMITTED IN THE REACTION $^{12}C(d,p)^{13}C$. Gorodetzky, Serge; Beck, Francis; Knipper, Albert (Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., Ser. A and B, 267: 78-81(July 1, 1968). (In French).

The distribution–polarization technique was used to study the plane polarization of 170-keV gamma rays emitted in the reaction $^{12}C(d,p)^{13}C$. This technique, which consists in comparing the angular distribution and the plane polarization of a gamma ray measured under the same experimental conditions, permits the determination of the mixing coefficients in the case of a fixed spin sequence. These measurements were made for the resonance of $E_d = 2490$ keV. The carbon-13 level scheme and the spectra for the 170-keV gamma rays from this reaction are shown. (J.F.P.)

## Nuclear Properties and Reactions, 20 ≤ A ≤ 89

*Refer also to abstracts 45093, 45939, 46218, 46221, 46335, 46695, 46711, and 46808.*

**46729** (AECL-3157) PHYSICS DIVISION PROGRESS REPORT, APRIL 1, 1968–JUNE 30, 1968. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 88p. (PR-P-78). Dep. CFSTI. CAN $2.00.

A thin window transmission counter at the entrance of the magnetic spectrograph was added to the spark chamber system described previously. Measurement of the time of flight of a particle between this counter and the proportional counter in the focal plane provides mass identification and also eliminates background due to electrons. A counter telescope for the identification of charged particles is working well in experiments on the $^{26}Mg(p,d)$ and (p,t) reactions. The PDP-1 computer uses a triton range-energy table stored in the computer to calculate, on line, the apparent thickness of the dE counter from the dE and E signals. This will be the true thickness only if the particle is a triton, but digital windows set on the thickness spectrum permit the selection of other particle types; very good discrimination is achieved. A similar system is used in the (d,pf), (d,tf) fission experiments. Experiments are continuing on the Coulomb excitation of $^{24}Mg$ by $^{35}Cl$ and $^{4}He$ ions, and on the Coulomb excitation of $^{35}Cl$ projectiles with both $^{24}Mg$ and $^{12}C$ targets. Lifetime measurements in $^{35}Cl$ using the $^{32}S(\alpha,p)$ reaction have now been completed. Triple angular correlations of gamma rays from the reaction $^{31}P(\alpha,p)^{34}S$ were measured with the Lotus goniometer, and the data are being analyzed. Magnetic excitations in antiferromagnetic $KMnF_3$ doped with 20% of Co were studied at low temperatures by neutron inelastic scattering. The $KMn:CoF_3$ crystal has the cubic perovskite structure and below 92.4°K the spins order antiferromagnetically. Magnetic scattering was observed at low temperatures at a frequency of 6.51 ± 0.07 THz; its frequency and intensity decreased as the temperature was raised and, above the Néel temperature, no scattering remained. It is believed to arise from a localized magnon resulting from the splitting of the ground state doublet of the $Co^{++}$ ion by the exchange field of the neighbouring Mn ions. The calculated frequency of this local mode is in excellent agreement with experiment. Its intensity varies more strongly with momentum transfer than does the analogous mode in $Mn:CoF_2$, which suggests that the magnetic excitation is less strongly localized on the Co ion in Co-doped $KMnF_3$ than in Co-doped $MnF_2$. Earlier measurements on sodium nitrite had confirmed the existence of satellite Bragg reflections on either side of the regular lattice points at wave-vectors $aq/2\pi = \pm(0.11, 0, 0)$, at temperatures between 163.5°C and 164.5°C. The intensity of these satellites has now been measured on either side of several lattice points to find the structure of this antiferroelectric phase. The results are consistent with a model in which the nitrogen atom is situated on either the positive or negative b axis. The critical scattering associated with the formation of this structure was measured up to 200°C. The results show that the scattering is largely confined to the a axis in agreement with earlier X-ray measurements. Furthermore, the half-width in frequency of this scattering is always much less than the instrumental resolution, showing that each $NO_2$ group spends a long time (> 50 vibrational periods) in each equilibrium site compared with the time it spends in jumping between the equilibrium sites. A theoretical study of scattering from macroscopic systems is making use of the formalism of Mori, who considered some years ago the general problem of evaluating correlation functions. His formalism has been found to generate the most important results of slow neutron scattering theory as successive approximations in a continued fraction representation. These results have previously been derived independently of one another, usually on the basis of crude heuristic models, and it was not clear whether they had any physical significance beyond being qualitatively correct. Earlier studies of charge collection in coaxial Ge(Li) detectors had suggested that, in constructing a spectrometer from a crystal exhibiting preferential trapping of one carrier type, superior performance would be achieved if the trapped carrier moved radially outwards, from high to low electric field regions. To check this, two coaxial diodes were made from a crystal known to have hole-trapping characteristics. One was made in the conventional fashion, by drifting lithium inwards from the outer surface; the second was made by drifting lithium outwards from the surface of a central hole. Trapping effects were observable to 2000 V applied bias in the conventional detector, but were negligible with 1000 V applied to the second detector, which gave much better resolution at all applied voltages. Two more large crystals have been grown in the crystal furnace at the Ontario Research Foundation; both were grown in a hydrogen atmosphere. Tests on pieces of these crystals are still incomplete, but the spectrometer qualities appear to be similar to those of the crystal grown in vacuum. No significant improvement in the voltage rating during draft was observed over that of the vacuum grown crystal. All crystals so far have shown some preferential electron trapping when operated as spectrometers. (auth)

**46730** (APDA-217) EVALUATED NEUTRON CROSS SECTIONS OF $^{23}Na$ FOR THE ENDF/B FILE. Pitterle, T. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1968. Contract AT(11-1)-865. 43p. (ENDF-121). Dep. CFSTI.

An evaluation of $^{23}Na$ neutron cross section data was carried out for the ENDF/B file. Data were evaluated from $10^{-4}$ eV to 15 MeV for the following neutron reactions: total, elastic scattering including Legendre polynomial expansions of the angular dependence, nonelastic, inelastic including resolved levels, $(n,\gamma)$, (n,p), $(n,\alpha)$, and (n,2n). Graphs of the evaluated data are compared with experimental data. (auth)

**46731** (COO-1746-8) RESEARCH IN NUCLEAR PHYSICS. Progress Report No. 1, October 1, 1967-June 1, 1968. Steffen, R. M. (Purdue Univ., Lafayette, Ind. Nuclear Physics Lab.). June 15, 1968. Contract AT(11-1)-1746. 99p. Dep. CFSTI.

Developments in the experimental research program included the analysis of data on the reactions $^{12}C(^3He,\alpha)^{11}C$ and $^{16}O(^3He,\alpha)^{15}O$ and on $\alpha$ elastic and inelastic scattering by $^{19}F$; measurement of the static quadrupole moments of the first excited $2^+$ states of $^{74}Ge$, $^{76}Ge$, $^{56}Fe$, and $^{108}Pd$; investigation of the effect of magnetic hyperfine interactions on $\gamma-\gamma$ directional correlations from $^{169}Tm$ in Fe; measurement of the g-factors of excited states in $^{75}As$, $^{190}Os$, and $^{192}Pt$; measurement of the hyperfine field at $^{103}Rh$ in Fe at 305.5°K; measurement of multipole mixing ratios for transitions in the decay of $^{192}Ir$; measurement of conversion electron particle parameters for M4 transitions in $^{207}Pb$, $^{197}Hg$, and $^{117}Sn$; measurements of $\beta-\gamma$ directional correlations for first-forbidden transitions in the decay of $^{124}Sb$ and for K-forbidden transitions in the decay of $^{160}Tb$; $\beta-\gamma$ circular polarization measurements on $^{60}Co$; and measurement of the lifetimes of short-lived states in $^{114}Cd$, $^{60}Ni$, $^{192}Pt$, and $^{49}Ti$. Experiments for studying $\beta$ decay matrix elements in first-forbidden transitions were analyzed from the standpoint of the accuracy attainable. The theoretical program dealt with the treatment of the many-body problem, including the three-body problem, and with the radiative detection of nuclear magnetic resonance of isomeric states. Developments in instrumentation included a high-resolution Si(Li) electron spectrometer, a multicoincidence module, and instruments for measuring azimuthal shifts of $\gamma-\gamma$ directional correlations. Several computer programs for off-line and on-line data analysis were developed. (D.C.W.)

**46732** (NP-17528) IDENTIFICATION AND NUCLEAR SPECTROSCOPY OF SEVERAL SHORT LIVED FISSION PRODUCTS WITH AN ON-LINE MASS-SEPARATOR. Eidens, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkorper- und Neutronenphysik). July 1968. 58p. (In German). Dep.

At the focus of the helium-filled mass separator for fission products at the Juelich-2 research reactor, an apparatus for nuclear spectroscopy on short-lived fission products was constructed. A mass calibration of the separator was carried out by the use of the $\gamma$ radiation of known long-lived fission products. In the unknown short-lived fission products, the half-life of the decay was determined on the basis of some very intense $\gamma$ lines. The lines found were assigned to 8 nuclides, for which the following half-lives and Q-values of the $\beta$ decay were measured: $^{84}Se$, 3.5 ± 0.1 min and 1.8 ± 0.1 MeV; $^{91}Kr$, 7.9 ± 0.5 sec and 5.7 ± 0.4 MeV; $^{97}Y$, 1.11 ± 0.03 sec and 5.7 ± 0.2 MeV; $^{99}Nb$, 14.3 ± 0.6 sec and 3.7 ± 0.2 MeV; $^{99}Zr$, 2.4 ± 0.1 sec and 4.5 ± 0.2 MeV; $^{100}Nb$, 6.6 ± 0.2 sec and 6.5 ± 0.3 MeV; $^{101}Nb$, 7.0 ± 0.2 sec and 4.6 ± 0.2 MeV; and $^{101}Zr$, 3.3 ± 0.6 sec and 6.5 ± 0.7 MeV. In three cases the decay curves obtained permit the following estimation for the half-lives of the mother nuclides: $^{97}Sr$, 0.4 ± 0.3 sec; $^{99}Y$, 0.8 ± 0.7 sec; and $^{100}Zr$, 1.0 ± 0.9 sec. (tr-auth)

**46733** MEASUREMENT OF THE $\epsilon/\beta^+$ RATIO IN THE DECAY OF $^{22}Na$ AND $^{74}As$. Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary); Varga, D.; Uchrin, J. Nucl. Phys., A116: 637-42(1968).

The $\epsilon/\beta^+$ ratios of the transitions from $^{22}Na$ and $^{74}As$ to the first excited state of $^{22}Ne$ and $^{74}Ge$ were measured to be 0.1042 ± 0.0010 and 1.288 ± 0.018, respectively. The coincidence method was applied, using a $4\pi$ $\beta$ scintillation detector and NaI and Ge(Li) gamma-ray detectors. (auth)

**46734** EXCITATION OF ISOBARIC ANALOGUE STATES IN (p,n) REACTIONS AT 30 AND 50 MeV AND THE ISOSPIN DEPENDENCE OF THE OPTICAL MODEL. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng.); Bonner, B. E.; Friedman, E.; Tschlaer, C.; Williams, L. E.; Clough, A. S.; Hunt, J. B. Nucl. Phys., A116: 643-72(1968).

Cross sections for the excitation by the (p,n) reaction of isobaric analog states in residual nuclei have been measured at 30 and 50 MeV. An analysis of the results has been performed in terms of a macroscopic (t · T) potential. The results favor a complex potential whose real part has a surface-peaked form. A purely real potential of magnitude given by proton scattering data fits the shape but not the absolute values of the experimental results. The results from some nuclei have also been analyzed in terms of a microscopic description of the interaction and reasonable fits obtained using a Yukawa interaction with a range of 0.8 fm. (auth)

**46735** AN INVESTIGATION OF THE ODD-PARITY STATES OF $^{40}Ca$ WITH THE TABAKIN INTERACTION AND THE MSDI. Dieperink, A. E. L.; Leenhouts, H. P.; Brussaard, P. J. (Univ., Utrecht). Nucl. Phys., A116: 556-76(1968).

The realistic Tabakin nucleon-nucleon interaction and the effective modified surface delta interaction (MSDI) are applied to determine the energy spectrum and wave functions of the low-lying odd-parity states in $^{40}Ca$. The calculations are performed in the TDA and the RPA. The wave functions are used to determine $\gamma$-transition rates and mean lifetimes. (auth)

**46736** THE $^{63}Cu(p,p'\gamma)^{63}Cu$ AND $^{65}Cu(p,p'\gamma)^{65}Cu$ REACTIONS AT 6.5 MeV. Smith, D. L.; Young, Helen J.; Enge, H. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A116: 545-55(1968).

The gamma-ray de-excitation of the first five excited states of $^{63}Cu$ and $^{65}Cu$ was studied by means of the $^{63,65}Cu(p,p'\gamma)^{63,65}Cu$ reactions. Thin-film targets of copper enriched in $^{63}Cu$ and $^{65}Cu$, respectively, were bombarded with a 6.5 MeV proton beam from the MIT-ONR Van de Graaff generator. A gamma spectrum for each level was obtained in coincidence with protons of the right energy, as determined by a high-intensity magnetic spectrometer designed in this laboratory. Measured relative intensities of the de-excitation gamma rays were not corrected for angular correlation effects. The experimental results provide evidence for spin and parity assignments of $\frac{1}{2}^-$ to the 1412 keV fourth excited level of $^{63}Cu$ and to the 1623 keV fourth excited level of $^{65}Cu$. A striking over-all similarity in the decay schemes of the two nuclei is observed. (auth)

**46737** DEFORMED STATES IN $^{42}Ca$. Flowers, B. H.; Skouras, L. D. (Univ. of Manchester, Eng.). Nucl. Phys., A116: 529-44(1968).

The energy spectrum and transition rates in $^{42}Ca$ are explained by considering admixtures of deformed and shell-model states for the low-lying levels. Using three variational parameters (the deformation parameters) and two fitted parameters (effective charge and $f_{\frac{7}{2}}-d_{\frac{3}{2}}$ energy splitting). The lowest six positive-parity states and the known transition rates are reproduced to a good approximation. Two types of residual two-body interactions are used, the Kallio-Koltveit interaction and a Yukawa central potential with a Rosenfeld exchange mixture; the results obtained do not indicate that the Kallio-Kolltveit potential is a better representation of the residual interaction than the Rosenfeld one. (auth)

**46738** INVESTIGATION OF $^{42}Sc$ BY THE REACTION $^{40}Ca(^3He,p)^{42}Sc$. Puehlhofer, F. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A116: 516-28(1968).

The level structure of $^{42}Sc$ was studied by means of the reaction $^{40}Ca(^3He,p)^{42}Sc$ at 18-MeV incident energy. Angular distributions were measured for states up to 4 MeV of excitation energy and $J^\pi$, T assignments are made. A shell-model calculation using an effective interaction was performed in order to describe the two-particle states. The calculated wave functions were used with a distorted-wave analysis to predict theoretical cross sections of the $(^3He,p)$ reaction. Very good agreement was obtained for the transitions to the excited states. The ground state transition, however, was about three times stronger than predicted. (auth)

**46739** ON THE BRANCHING RATIOS OF THE LOWEST $J^\pi = \frac{1}{2}^+$ STATES IN THE MIRROR NUCLEI $^{23}Na$ AND $^{23}Mg$. Dubois, J. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys., A116: 489-96 (1968).

The branching ratio of the electromagnetic decay of the $J^\pi = \frac{1}{2}^+$ level at 2.393 MeV in $^{23}Na$ was determined from a study of the $^{22}Ne(^3He,d\gamma)^{23}Na$ reaction using particle-gamma coincidence technique. Theoretical calculations using the collective model and including isospin as a good quantum number seem to account for the experimental result as well as the vastly different branching ratio for the corresponding level in $^{23}Mg$. (auth)

**46740** HEXADECAPOLE MOMENT EFFECTS IN MULTIPLE COULOMB EXCITATION. Desiderio, A. M.; Johnson, W. R. (Univ. of Notre Dame, Ind.). Nucl. Phys., A116: 577-9(1968).

The effect of the electric hexadecapole moment of the first excited state in $^{56}Fe$, $^{114}Cd$, and $^{152}Sm$ on the inelastic scattering differential cross section in multiple Coulomb excitation was investigated and found to be small. (auth)

**46741** THE $^{23}Na(p,\gamma)^{24}Mg$ REACTION AND THE GIANT DIPOLE RESONANCE IN $^{24}Mg$. Bearse, R. C. (Argonne National Lab., Ill.); Meyer-Schuetzmeister, L.; Segel, R. E. Nucl. Phys., A116: 682-94(1968).

The $^{23}Na(p,\gamma)^{24}Mg$ reaction was studied over the region of excitation corresponding to the giant dipole resonance. Gamma rays to the ground state and to the first and to the second plus third excited states were observed. The $(p,\gamma_0)$ cross section is on the average smaller than it is in other doubly even nuclei in this region. The $(p,\gamma_1)$ cross section is considerably larger than the $(p,\gamma_0)$ and clearly follows a giant-resonance shape. A part of the giant resonance built upon the second and/or third excited states was also observed. A fluctuation analysis finds the coherence

width to be about 75 keV. The angular distributions of both $\gamma_0$ and $\gamma_1$ show the usual small energy variation that has come to be associated with the giant resonance. (auth)

**46742** INELASTIC PROTON SCATTERING FROM $^{42}$Ca AND $^{44}$Ca AND ANALYSIS IN TERMS OF SHELL-MODEL FORM FACTORS. Bane, J. C. (Univ. of Colorado, Boulder); Kraushaar, J. J.; Ridley, B. W.; Stautberg, M. M. Nucl. Phys., A116: 580-608(1968).

Inelastic proton scattering measurements were carried out at 22.9 MeV from $^{42}$Ca and $^{44}$Ca. Angular distributions were measured for 11 inelastic proton groups from $^{42}$Ca and eight from $^{44}$Ca. The experimental differential cross sections were compared with distorted wave calculations using a collective-model interaction in which both the real and imaginary terms of the optical potential were deformed. Extensive comparisons are performed with distorted wave calculations using a shell-model description for the nuclear states as well as more complicated wave functions with a collective component. An empirical core polarization correction is used. The analysis is shown to be consistent with $^{50}$Ti scattering data. (auth)

**46743** STUDY OF LEVELS IN THE HIGHLY EXCITED $^{29}$Si NUCLEUS. Coppola, M.; Knitter, H.-H. (EURATOM, Geel, Belg.). Z. Phys., 213: 185-91(1968).

The results of fast neutron elastic scattering measurements on natural silicon in the energy range 0.57 to 2.28 MeV were used for comparison with the nuclear resonance theory. Assignment of spin and parity to some highly excited states in $^{29}$Si was possible. (auth)

**46744** g-FACTOR OF THE 243-keV LEVEL IN $^{88}$Y. Treytl, William J.; Matthias, E. (Univ. of California, Berkeley). pp 145-50 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The g-factor and half-life of the 243-keV 2- state in $^{88}$Y were measured. The values obtained are $g = -0.53 \pm 0.03$ and $t_{1/2} = 28.5 \pm 2.1$ nsec. The g-factor favors the configuration $[(P_{\frac{1}{2}})_\pi(d_{\frac{5}{2}})_\nu]_{2^-}$. (auth)

**46745** NUCLEAR QUADRUPOLE MOMENT OF $^{57m}$Fe FROM HYPERFINE INTERACTIONS IN $\alpha$-$Fe_2O_3$. Muir, A. H. Jr. (North American Aviation Science Center, Thousand Oaks, Calif.); Wiedersich, H.; Artman, J. O. pp 236-44 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

Moessbauer effect measurements of the quadrupole coupling constant in $\alpha$-$Fe_2O_3$, $e^2qQ = +0.880 \pm 0.032$ mm/sec, were combined with an electric field gradient calculation based on new structural data to yield a nuclear quadrupole moment $Q(^{57m}Fe) = +0.300 \pm 0.035$ b. The EFG calculation uses the same cluster method and polarization correction of the previous work by Artman, which gave $Q = +0.41$ b. The major change in Q results from the use of refined $\alpha$-$Fe_2O_3$ structure parameters. It is found that the EFG calculation is very sensitive to slight variations in these parameters, particularly the iron special-position parameter. The present result is in agreement with Q determinations by Ingalls (for $Fe^{2+}$) and by Sternheimer and by Sharma and Das (both for $Fe^{3+}$). It is found that the thermal history of the samples can influence significantly the measured quadrupole coupling constant. (auth)

**46746** MOESSBAUER EXPERIMENTS WITH $^{61}$Ni. Love, John C. (Oak Ridge National Lab., Tenn.); Czjzek, Gordon; Spijkerman, J. J.; Snediker, D. K. pp 124-9 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Using the $^{61}$Ni Moessbauer effect, the ratio of the magnetic moments of $^{61}$Ni nuclei in the first excited state and the ground state was measured: $\mu(5/2)/\mu(3/2) = -0.559 \pm 0.012$. Hyperfine fields at nickel nuclei in iron (241 ± 7 kG) and in a Ni(85%) Cr(15%) alloy (≈ 15 kG) were determined. Very approximate values for isomer shifts of some nickel alloys, $NiF_2$, and NiO are given. (auth)

**46747** HYPERFINE STRUCTURE OF THE 67.4-keV TRANSITION IN $^{61}$Ni. Erich, U.; Quitmann, D. (Technische Hochschule, Darmstadt, Ger.). pp 130-2 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

With the Moessbauer technique, the hyperfine splittings of the 67.4-keV transition in $^{61}$Ni was studied. Sources of $^{61}$Cu in Cu-metal were produced by the reaction $^{63}$Cu(γ,2n)$^{61}$Cu. In an absorber containing 4% Ni (81% $^{61}$Ni) in Fe metal, the magnetic splitting of the $^{61}$Ni ground state was resolved; from this measurement, made at 4.2°K, $g_E/g_g = -0.346 \pm 0.015$ was obtained for the ratio of the g-factors. In NiO, the hyperfine field was found to be 98 kOe at 4.2°K. (auth)

**46748** AN ANALYSIS OF $^{23}$Na NEUTRON CROSS SECTIONS IN THE MeV REGION. Benzi, V.; Zuffi, L. pp 253-64 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The available experimental data on the neutron cross sections of $^{23}$Na are compared with the predictions of the optical model and the Hauser-Feshbach formalism. For neutron energies above 4 MeV, a theoretical estimate of the cross sections is given using some parameters that were obtained by an analysis of data for $^{27}$Al. (D.C.W.)

**46749** STATISTICAL ANALYSIS OF THE NEUTRON CAPTURE CROSS SECTIONS FOR INTERMEDIATE MASS NUMBER NUCLIDES IN THE MeV REGION. Benzi, V.; Bortolani, M. V. pp 265-81 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

An analysis of neutron radiative capture cross sections in the MeV range for nuclei with A = 70 to 170 is presented. A simple statistical model, in which the main features of the interacting nucleus are given by a level density formula, is briefly described. The theoretical results are systematically compared with experimental data, in the range of fission-product mass numbers, for incident neutron energies above 1 MeV. (D.C.W.)

**46750** INTERNAL FIELD FOR Fe IONS IMPLANTED IN IRON. Sprouse, G. D.; Hanna, S. S. (Stanford Univ., Calif.). pp 761-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The magnetic moment of the second excited state of $^{57}$Fe was measured by observing the precession of the state in an external field. The agreement of the result with that of Koerner et al., who used the internal field in iron, indicates that this latter field assumes its "correct" value in times of a few nanoseconds. Measurements of lifetimes and magnetic moments were performed on higher excited states of $^{57}$Fe. (auth)

**46751** PRECESSION MEASUREMENT OF THE 845-keV LEVEL OF $^{56}$Fe IMPLANTED IN IRON AFTER A (p,p') REACTION. Kalish, R.; Kossler, W. J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 752-60 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

An integral precession measurement on a level populated through a compound-nucleus reaction is reported. The $^{56}$Fe(p,p') reaction was used to populate the first excited $2^+$ state ($\tau = 10.6$ psec) of $^{56}$Fe. The excited nuclei, with an average recoil energy of about 200 keV, were stopped in polarized iron, and their precession angle in the internal magnetic field was measured by observing the integral precession of the angular distribution of the γ-ray single spectrum. The measured value is $\omega\tau = 0.0094 \pm 0.0023$, in good agreement with previously reported precession angles, which were measured by radioactivity methods. The positive result observed here may indicate that the anomalous result $0.0004 \pm 0.001$ observed in Coulomb excitation work is due to phenomena occurring in the first part of the flight of the recoiling ion, while its energy is still in the MeV range. (auth)

**46752** OPTICAL PUMPING OF SHORT-LIVED β EMITTERS. Besch, H. J.; Koepf, U.; Otten, E.-W. (Univ., Heidelberg). pp 789-92 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Sodium-21 nuclei, produced by the reaction $^{20}$Ne(d,n)$^{21}$Na, were polarized by means of optical pumping in the atmosphere of the target. An asymmetry of +0.3% of the subsequent β decay was found. Radiofrequency transitions between hyperfine levels of the

atomic ground state of $^{21}$Na were detected by a decrease of the decay assymmetry. (auth)

**46753** ON THE INTERFERENCF BETWEEN RAYLEIGH AND MOESSBAUER SCATTERING AND THE SPIN DEPENDENCE OF RAYLEIGH SCATTERING. Renz, W.; Appel, H. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 370-8 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The interference between Rayleigh and Moessbauer scattering was observed for polycrystalline iron foils. From the experimental data, the cross section for Rayleigh scattering and the size of the interference term could be deduced. In an additional experiment, circularly polarized $\gamma$ rays were scattered from polarized electrons. The comparison of the Rayleigh scattering cross sections and the interference terms for left and right circularly polarized $\gamma$ rays results in a pronounced spin dependence of Rayleigh scattering. (auth)

**46754** STUDY OF THE FLUCTUATIONS OF THE NEUTRON EXCITATION FUNCTION FOR THE REACTION (p,n) ON $^{51}$V AT LOW ENERGIES. Espi, Gisele (Univ. de Lyon, Villeurbanne, France). Compt. Rend., Ser. A and B., 266: 1463-4(June 10, 1968). (In French).

A study is made of fluctuating experimental curves obtained by means of the fluctuation model of Lane and Lynn and that of Ericson. (tr-auth)

**46755** DEFORMATIONS IN THE CALCIUM REGION. Gerace, William J. Princeton, N. J., Princeton Univ., 1967. 104p. Thesis.

Collective states are admixed with the usual shell-model states in an attempt to construct a model capable of explaining certain properties of nuclei in the Ca region. These properties, which can not be explained by the shell model alone, include anomalously large electromagnetic transition rates and the number of low-lying energy levels. Deformed states are constructed according to an isospin coupling scheme which favors states that have low total isospin but which have particles and holes separately coupled to maximum allowable isospin. Matrix elements are then calculated between these states and shell model states using two-body matrix elements derived from the Hamada–Johnston realistic nucleon–nucleon force. Treating the position of the unperturbed deformed band of states as a parameter, wave functions for physical states are obtained. These wave functions are then used to predict values for some reduced electromagnetic transition rates and single-particle strengths. These techniques are applied to nuclei in the vicinity of A = 40. Where possible, predicted quantities are compared with experimental results. The deformed model shows a definite improvement over a pure shell model description of these nuclei, however not all properties of these nuclei can be explained. (Disser. Abstr.)

**46756** ANISOTROPY OF NUCLEAR RESONANCE FLUORESCENCE YIELDS OF $^{28}$Si WITH ALUMINUM SINGLE-CRYSTAL SOURCES. Kalus, J.; Thaler, H. J. (Technische Hochschule, Munich). Z. Naturforsch., 23a: 283-7(Feb. 1968). (In German).

By use of a $\beta-\gamma$ decay cascade, nuclear resonance fluorescence can be observed on the 1.772-MeV level of $^{28}$Si. The anisotropy of the nuclear resonance fluorescence, which is to be expected because of the direction-dependent deceleration of the decaying silicon nucleus (energy up to 215 eV) in an aluminum single crystal, was experimentally found. In a direction diagram for the (110) - plane, oscillations of the nuclear resonance yield up to 13% exist. The pattern of the nuclear resonance yield calculated with an improved rigid sphere model with qualitative consideration of the deceleration agrees satisfactorily with the measured pattern. (tr-auth)

**46757** HALF-LIFE OF $^{35}$S. Woodhouse, E. J.; Norris, T. H. (Oregon State Univ., Corvallis). Contract AT(45-1)-244. J. Inorg. Nucl. Chem., 30: 1373-6(July 1968). (RLO-244-7).

A new value of 87.39 ± 0.10 days for the half-life of $^{35}$S was obtained by following the decay of nine samples over a period of approximately one year. (auth) (UK)

**46758** DETERMINATION OF THE NEUTRON CAPTURE RESONANCE INTEGRALS OF $^{55}$Mn, $^{115}$In, $^{121}$Sb, $^{123}$Sb, AND $^{139}$La. Orvini, E. (Univ., Pavia, Italy); Gaggero, G.; Lesca, L.; Bresesti, A. M.; Bresesti, M. J. Inorg. Nucl. Chem., 30: 1353-60 (July 1968).

The resonance integrals were measured by activation techniques taking the neutron capture reaction on $^{197}$Au as the reference. The following values were obtained for the resonance integrals with a lower limit 0.55 eV: $^{55}$Mn, 13.7 ± 0.7 b; $^{115}$In, 3350 ± 150 b; $^{121}$Sb, 200 ± 17 b; $^{123}$Sb, 116 ± 10 b; $^{139}$La, 10.8 ± 1.1 b. The reported errors for $^{121}$Sb, $^{123}$Sb, and $^{139}$La are mainly due to uncertainty in the knowledge of the 2200 msec cross sections. (auth) (UK)

**46759** STUDY OF THE DECAY OF $^{83m}$Se (69s) BY MEANS OF A MAGNETIC MULTICHANNEL BETA SPECTROMETER. Schussler, F. (CEN, Grenoble, France). J. Phys. (Paris), 29: 385-90(May-June 1968). (In French).

Discrepancies concerning the decay scheme of $^{83m}$Se (69 s) prompted its re-examination. The beta and gamma spectra of targets produced by $^{82}$Se(n,$\gamma$), were investigated with a magnetic multichannel beta spectrometer and with a 5-cm$^3$ lithium-drifted germanium detector, respectively. A detailed examination of the beta spectrum led to the characterization of the following branching ratios: 3,920 ± 20 keV (31 ± 0.7%), 2,880 ± 30 keV (34 ± 1.5%), and 1,780 ± 100 keV (35 ± 3%). The gamma-ray spectrum is in good agreement with these results. (auth)

# Nuclear Properties and Reactions, A ≥ 90

*Refer also to abstracts 45045, 46234, 46257, 46262, 46269, 46695, 46729, 46731, 46732, 46734, 46740, 46749, 46758, 46813, 46816, 46830, and 46859.*

**46760** (ANL-Trans-636) EFFECT OF SUBSHELLS WITH A NEUTRON NUMBER N = 152 UPON THE QUANTITY $\gamma_n\gamma_f$ IN REACTIONS WITH HEAVY IONS. Mikheev, V. L.; Polikanov, S. M. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from pp 67-70 of Trudy Mezhdunarodnoi Konferentsii po Fizike Tyazhelykh Ionov Dubna, 13-19 Oktyabrya 1966 G. Vypusk 2. Sintez Issledovanie Svoistv Izotopov Transuranovyke Elementov. 7p. Dep. CFSTI.

The mean ratio of the neutron width and fission width for elements with subshells with 152 neutrons was determined through study of the reactions $^{239}$Pu($^{18}$O,5n)$^{252}$No, $^{239}$Pu($^{12}$O 4n)$^{253}$No, $^{242}$Pu($^{18}$O,4n)$^{254}$No, $^{242}$Pu($^{18}$O,5n)$^{253}$No, $^{242}$Pu($^{18}$O,4n)$^{256}$No, and $^{242}$Pu($^{18}$O,5n)$^{255}$No. (J.W.R.)

**46761** (APED-5398) SUMMARY OF FISSION PRODUCT YIELDS FOR $^{235}$U, $^{238}$U, $^{239}$Pu, AND $^{241}$Pu AT THERMAL, FISSION SPECTRUM AND 14-MeV NEUTRON ENERGIES. Meek, M. E.; Rider, B. F. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Mar. 1, 1968. 106p.

A tabulation of experimental data, extrapolated chain yields, calculated charge distributions and a recommended value for all known fission products is presented. The fissionable nuclides covered were $^{235}$U at thermal, fission spectrum, and 14-MeV neutron energies; $^{238}$U at fission spectrum and 14 MeV energies; $^{239}$Pu at thermal and fission spectrum energies; and $^{241}$Pu at thermal energies. (auth)

**46762** (CNAEM-52) PARAMETERS FOR THE FIRST AND SECOND NEUTRON RESONANCES IN $^{149}$Sm. Akyuez, O. R.; Cansoy, C.; Domanic, F.; Oergeevren, Y. (Cekmece Nuclear Research Center, Istanbul (Turkey)). June 1968. 13p. Dep.

The total neutron cross section of natural samarium was measured in the energy range from 0.06 to 1 eV with a crystal spectrometer using the Be(10$\bar{1}$1) and Be(12$\bar{3}$1) crystal planes as monochromators. In this region two resonances due to $^{149}$Sm are present. After correction for second order containation caused by the monochromator, Doppler corrections were applied to both resonances. Corrections for spectrometer resolution were needed only for the second resonance. Both resonances were fitted separately to the Breit-Wigner single-level formula by the method of least squares. The analysis gives the parameters of the resonances as follows: $E_o$ = 0.0973 ± 0.0012 eV, $\sigma_o$ = 18348 ± 376 b, $\Gamma$ = 0.0635 ± 0.0013 eV, $\Gamma_n$ = (0.0773 ± 0.0025) × $10^{-3}$ eV for the first and $E_o$ = 0.872 ± 0.012 eV, $\sigma_o$ = 2948 ± 68 b, $\Gamma$ = 0.0635 ± 0.0015 eV, $\Gamma_n$ = (0.1114 ± 0.0041) × $10^{-3}$ eV for the second. The statistical weight factor g was taken to be 9/16 for both levels. (auth)

**46763** (EIR-134) TOTAL CROSS SECTION OF CADMIUM FOR NEUTRONS OF ENERGY BETWEEN 0.01 eV AND 10 eV. Widder, F.; Brunner, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). June 1968. 12p. Dep.

The total cross section of cadmium for 0.01- to 10-eV neutrons was measured using a fast chopper. Parameters for the 0.178-eV resonance were determined. (J.W.R.)

**46764** (IAE–1443) THE INTENSITIES OF PARTIAL RADIATIONAL TRANSITIONS INTO THE FUNDAMENTAL AND FIRST EXCITED STATES IN RESONANCES OF THE ISOTOPE $^{155}$Gd. Danelyan, L. S.; Efimov, B. V.; Sotnikov, S. K. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1967. 20p. (In Russian). Dep.

Measurements with a two-crystal scintillation spectrometer were made of the total values of the intensities of gamma transitions into the fundamental and first excited states in 23 resonance reactions $^{155}$Gd(n,$\gamma$)$^{156}$Gd. The experimental distribution of the intensities agrees better with two-component Porter-Thomas distributions with different average values of the intensity than with $\gamma$ = 1 and $\gamma$ = 2 distributions. Analysis of the available data indicates the possibility of the existence of a correlation between the magnitudes of the intensities and the spins of the initial states. (auth)

**46765** (JINR-P6-3945) NEW SHORT-LIVED ACTIVITIES $^{163}$Y, $^{165m}$Tm, $^{163m}$Tm, $^{161m}$Tm, $^{159}$Tm. Gromov, K. Ya.; Zhelev, Zh. T.; Kalinnikov, V. G.; Malek, Z.; Nenov, N.; Pfrepper, G.; Shtrusnyi, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 17p. (In Russian). Dep.

Five new activities were identified according to their genetic connection with the daughter activities. The Szillard–Chalmers reaction was used in phthalocyanine complexes. It is possible that the isomeric states $^{165m}$Tm, $^{163m}$Tm, and $^{161m}$Tm are connected with the Nilsson 7/2$^+$/404/ or 7/2$^-$/523/ states. (auth)

**46766** (LA-tr-68-19) ENERGY DEPENDENCE OF AVERAGE KINETIC ENERGY OF FISSION FRAGMENTS. Bol'shov, V. I.; Kuznetsov, V. F.; Smirenkin, G. N.; Ermagambetov, S. B.; Okolovich, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from report FEI–49. 11p. Dep. CFSTI.

Results are given of the relative measurements of average kinetic energy of fragments realized in the fission of $^{233}$U and $^{235}$U induced by neutrons with energy up to 2 MeV. Various ideas are discussed linking the origin of irregular measurements of the quantity investigated with the discrete spectrum structure of fission channels. Results of the experiment can be explained in terms of alternative propositions concerning the nature of the relation between deformation and nucleon degrees of freedom in the fissionable nucleus. (auth)

**46767** (NP–17532) INVESTIGATION OF MASS AND TIME DISTRIBUTION OF DELAYED NEUTRONS FROM THERMAL FISSION OF $^{235}$U WITH AN ON-LINE MASS SEPARATOR. Roeckl, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkorper- und Neutronenphysik). July 1968. 58p. (In German). Dep.

The delayed neutron emission in the thermal fission of $^{235}$U was investigated with a helium-filled mass separator. The neutron activity was measured in coincidence with the $\beta$ decay arising from neutron emission. From the measurement of the building up of the activity, the neutron yield for various times after fission was determined, and the half-life was obtained from the measurement of the activity decay. The mass distribution of these magnitudes was determined in the total fission yield range. The total neutron yield of light fission products is 1.05 neutrons/100 fissions and that of heavy fission products is only 0.53 neutrons/100 fissions. The measured mass and time dependence was compared with the previously published values for identified neutron emitters. Previously unidentified fractions of the activity in the mass range from 85 to 88 (half-life of 1 sec) and the mass range from 96 to 100 (half-life of 1.5 sec) are discussed. The yield variation between light and heavy fission products is indicated on the basis of the systematics of the delayed neutron emission and the previously unidentified activity was assigned to the mother nuclides $^{96}$Y and $^{99}$Y. (tr-auth)

**46768** (NYO-3664-6) EXPERIMENTAL STUDIES OF $^{136m}$Ba, $^{134m}$Xe, $^{127m}$Xe, AND $^{125m}$Xe. Winn, Willard Gary (Cornell Univ., Ithaca, N. Y. Nuclear Reactor Lab.). June 1968. Contract AT(30-1)-3664. 166p. (CURL-24). Dep. CFSTI.

Thesis.

The isomers $^{136m}$Ba, $^{134m}$Xe, $^{127m}$Xe, and $^{125m}$Xe were produced by pulsed neutron irradiation of enriched and natural samples in the Cornell TRIGA and transported by fast pneumatic transfer to a counting station where gamma and conversion electron spectra were observed using NaI(Tl), Ge(Li), and Si(Li) detectors. Because of the short half-lives of the isomers investigated, special techniques were devised to provide fast positioning of the sample for detection. $^{136m}$Ba($T_{\frac{1}{2}}$ = 307 ± 4 msec) and $^{134m}$Xe($T_{\frac{1}{2}}$ = 290 ± 17 msec) were studied with reference to analogous isomers in the N = 80 isotones. Each isomer decays by a three gamma cascade consistent with a 7$^-$ E3 4$^+$ E2 2$^+$ E2 0$^+$ scheme. Corresponding gamma energies are 168 ± 7, 1048.6 ± 0.7 and 819.3 ± 0.7 keV in $^{136m}$Ba; and 232.9 ± 1.5, 879.9 ± 1.4, and 845.9 ± 1.0 keV in $^{134m}$Xe. As the isomer $^{134m}$Xe had not been observed previously, internal conversion studies were performed to establish the multipolarity of the isomeric transition. An E3 assignment for the 233-keV transition results from its measured K/LMNO ratio of 1.83 ± 0.32 coupled with the measured gamma intensities of 62.8 ± 8.0, 94.4 ± 6.3, and 100 for the 233-, 880-, and 846-keV transitions, respectively. The conversion electron statistics for the 880- and 846-keV transitions did not allow definite assignments for these transitions; however, the gamma intensities are consistent with the E2 assignments suggested in Nuclear Data Sheets. A comparison of $^{136m}$Ba and $^{134m}$Xe with other isomers of the N = 80 isotones shows that most of the levels observed in the isomeric decays fit trends suggested by neighboring isomers. Only the assumed 4$^+$ state of $^{134}$Xe disagrees with such trends; the possibility was therefore considered of a second 4$^+$ state satisfying the level trends and lying near the 7$^-$ isomeric level. The gamma spectra, however, do not indicate that the isomer decays via this alternative 4$^+$ level, the upper limit for such branching being estimated at 2% of the observed decay mode. The techniques developed for xenon gas samples in the $^{134m}$Xe experiments were applicable to investigation of other isomers in xenon. The isomers $^{127m}$Xe($T_{\frac{1}{2}}$ = 74 sec) and $^{125m}$Xe($T_{\frac{1}{2}}$ = 58 sec) were studied. Each was observed to decay by a two gamma cascade consistent with a 9/2$^-$ E3 3/2$^+$ M1 1/2$^+$ scheme. The corresponding gamma energies are 172.5 ± 1 and 125.1 ± 1 keV in $^{127m}$Xe and 142.3 ± 0.5 and 112.1 ± 0.5 keV in $^{125m}$Xe. The suggestion in Nuclear Data Sheets that a 75-keV transition also occurs in the decay of $^{125m}$Xe was investigated; after examination of various background contributions it was concluded that the 75-keV peaks in various gamma spectra do not correspond to a nuclear transition. The internal conversion measurements on $^{125m}$Xe are also consistent with this result: from the assignment of E3 for the 142-keV transition (determined from $\alpha_{LMNO}$ = 1.83 ± 0.22), the assignment of M1 for the 112-keV transition (determined from $\alpha_K$ = 0.47 ± 0.07), and the assumption that the 75-keV peak is not a nuclear transition (thus $\alpha_K$ = 0), the K x-ray intensity observed in the spectrum could be explained. The statistical accuracy of the $^{127m}$Xe conversion electron lines was not sufficient to make multipolarity assignments; however, the line intensities are consistent with a 9/2$^-$ E3 3/2$^+$ M1 1/2$^+$ decay scheme. (The 1/2$^+$ ground state is known for $^{127}$Xe and assumed for $^{125}$Xe by analogy.) The appearance of a 9/2$^-$ state in this nuclear region is not compatible with shell model predictions and suggests that nuclear deformation may be present. For those isomers above which are created by thermal neutron capture, the thermal neutron activation cross sections were measured: $\alpha_{th}(^{136m}\text{Ba})$ = 13.9 ± 0.7 mb, $\alpha_{th}(^{127m}\text{Xe})$ = 0.23 ± 0.07 b, $\alpha_{th}(^{125m}\text{Xe})$ = 18 ± 4 b. These measurements were made for comparison with statistical theories for cross section ratios. The resonance integrals were also estimated for these isomers. (auth)

**46769** (ORNL-tr-1954) MIXED CONFIGURATIONS IN $^{169}$Yb. Michaelis, W.; Weller, F.; Schmidt, H.; Markus, G.; Fanger, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.). 51p. Dep. CFSTI.

The level structure of $^{169}$Yb was studied by radiative capture of thermal neutrons in $^{168}$Yb. High-resolution measurements of the gamma-ray spectrum were performed using a Ge(Li) anti-Compton spectrometer in the low-energy region and a Ge(Li) pair spectrometer for the high-energy transitions. More than 300 gamma lines were detected in the spectrum. The high accuracy of the data allows the application of Ritz' combination principle to excitation energies up to 1.5 MeV. The results clearly demonstrate the presence of remarkable band-mixing effects. The neutron binding energy was found to be 6867.21 ± 0.46 keV. Theoretical calculations were performed which take into account pair correlation, quasiparticle–phonon interaction, rotation-vibration interaction, and Coriolis coupling. The energy and structure of individual levels, the ratios of intensities for gamma-ray transitions, and multipolarity admixtures are predicted. In general, good agreement is achieved between the theoretical calculations and the experimental results. (auth)

**46770** (RLO–1759-14) FISSION STUDIES ON ELEMENTS BELOW POLONIUM. Progress Report, July 1, 1967–July 1, 1968. Neuzil, Edward F. (Western Washington State Coll., Bellingham). Contract AT(45-1)-1759. 10p. Dep. CFSTI.

The fission reactions $^{204}$Pb($\alpha$,f) and Ta($\alpha$,f) were investigated. Cross sections and fission-fragment mass distribution curves were obtained. (J.W.R.)

**46771** HALF-LIFE DETERMINATION OF $^{176}$Lu BY THREE COINCIDENCE METHODS. Winters, Ronald Ross. Blacks-

burg, Va., Virginia Polytechnic Inst., 1968. 90p.
Thesis.

The literature was found to quote values for the half-life of the $^{176}$Lu beta decay which differed by amounts greatly exceeding the quoted probable errors. It had been conjectured that this divergence might possibly be an indication that the proposed simple decay scheme was not accurate. That the decay scheme is adequate was verified in the present work. It was shown that when the geometry of the counting arrangement is taken into account, both $\gamma-\gamma$ and $\beta-\gamma$ coincidence techniques yield values for the half-life which are in agreement to within the experimental errors. The techniques of $\gamma-\gamma$ and $\beta-\gamma$ coincidence were applied to extended-source counting geometries for sources of nonuniform density. Equations were developed which were solvable for the activity of the source and which provided a quantitative estimate of the effects of the divergence from a point source geometry. The average value as determined in the present work for the half-life was $2.171 \pm 0.023 \times 10^{10}$ years. When the gamma energy spectrum (taken using a detector with energy resolution of 3.3 keV) was examined, only those photopeaks expected on the basis of the proposed decay scheme were observed. This supported the conclusion that the decay scheme, as proposed, satisfactorily describes the $^{176}$Lu → $^{176}$Hf decay. (Disser. Abstr.)

**46772** ON THE POSSIBILITY OF THE QUADRUPOLE MOMENTS RATIO DETERMINATION FOR THE EXCITED AND GROUND STATES OF $^{237}$Np ISOTOPE. Murin, A. N.; Romanov, Yu. F. Vestn. Leningrad. Univ., Ser. Fiz. Khim, No. 4, 156-7 (Feb. 1968). (In Russian).

The quadrupole moment ratio for the isomeric and ground state of $^{237}$Np is predicted to be 1, the quantity $\frac{1}{4}\, e^2qQ(c/E_\gamma)$ being 2.7 mm/sec. (auth)

**46773** LIFE-TIME-MEASUREMENT OF COULOMB-EXCITED LEVELS BY A PULSED-BEAM-TECHNIQUE. Richter, F. W.; Schuett, J.; Wiegandt, D. (Univ., Marburg, Ger.). Z. Phys., 213: 202-14(1968). (In German).

The half-lives of the first excited states of $^{150}$Nd, $^{152}$Sm, $^{154}$Sm, $^{160}$Gd, and $^{170}$Er were measured by pulsed beam-technique. Using the slope-method and a momentum-analysis the following results were obtained.

| | | |
|---|---|---|
| $^{150}$Nd | 131 keV-level | $T_{\frac{1}{2}} = (1.48 \pm 0.04)$ ns |
| $^{152}$Sm | 122 keV-level | $T_{\frac{1}{2}} = (1.44 \pm 0.03)$ ns |
| $^{154}$Sm | 82 keV-level | $T_{\frac{1}{2}} = (3.00 \pm 0.06)$ ns |
| $^{160}$Gd | 75 keV-level | $T_{\frac{1}{2}} = (2.68 \pm 0.06)$ ns |
| $^{170}$Er | 79 keV-level | $T_{\frac{1}{2}} = (1.88 \pm 0.05)$ ns (auth) |

**46774** ANALYSIS OF ISOMER SHIFT MEASUREMENTS OF THE 2+ → 0+ ROTATIONAL TRANSITION OF $^{170}$Yb. Atzmony, U.; Bauminger, E. R.; Hess, J.; Ofer, S. (Hebrew Univ., Jerusalem). pp 71-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

Previously reported isomer shift data on the 84-keV (2+ → 0+) rotational transition of $^{170}$Yb were analyzed using optical isotope shift data. The analysis yields, for the difference in the electron densities at the nucleus between $Yb^{3+}$ and $Yb^{2+}$ salts, the result $[D(3+) - D(2+)]_{Yb} = 2.7 \pm 0.6 \times 10^{26}$ cm$^{-3}$, which leads to the following values of the nuclear parameters: $\delta\langle r^2\rangle = 3.2 \pm 1.0 \times 10^{-3}$ fm$^2$ and $\Delta\beta/\beta = 1.9 \pm 0.6 \times 10^{-3}$. The measured value for $\Delta\beta/\beta$ is smaller than the value of $4.80 \pm 0.20 \times 10^{-3}$ predicted by the centrifugal stretching model of Davydov and Chaban when applied to axially symmetric nuclei. (auth)

**46775** ISOMER SHIFTS OF THE 87- AND 89-keV $\gamma$ RAYS OF $^{155}$Gd AND $^{156}$Gd. Henning, W.; Heunemann, D.; Kienle, P.; Koerner, H. J. (Technische Hochschule, Munich). pp 256-60 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

Isomer-shift measurements of the 87- and 89-keV $\gamma$ rays of $^{155}$Gd and $^{156}$Gd yield the ratio of the change of the mean-square-charge radii $\Delta\langle r^2\rangle$ ($^{156}$Gd, 89 keV)/$\Delta\langle r^2\rangle$ ($^{155}$Gd, 87 keV) = $-(0.35 \pm 0.05)$. From known electron density differences, the absolute values $\Delta\langle r^2\rangle$ ($^{156}$Gd, 89 keV) = $+(1.6 \pm 0.5) \times 10^{-3}$ fm$^2$ and $\Delta\langle r^2\rangle$ ($^{155}$Gd, 87 keV) = $-(4.5 \pm 1.5) \times 10^{-2}$ fm$^2$ are deduced. (auth)

**46776** MUONIC ISOMER SHIFT IN $^{181}$Ta. Backe, H.; Backenstoss, G.; Daniel, H.; Engfer, R.; Kankeleit, E.; Poelz, G.; Schmitt, H.; Tauscher, L.; Wien, K. (CERN, Geneva). pp 65-70 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

By use of the CERN muon beam facilities, $\gamma$ rays from the muonic excitation of $^{181}$Ta have been studied with Ge detectors; $\gamma$ lines of 136 and 165 keV were observed with a resolution of 1.5 keV, which can be interpreted as the de-excitation of the first and second rotational levels of $^{181}$Ta. By comparison with the corresponding $\gamma$ line in the radioactive decay of $^{181}$W, a positive shift of $+110 \pm 60$ eV of the 136-keV line was found, which can be explained as an increase of the rms charge radius of the first rotational state with respect to the ground state. By using Fermi-type nuclear charge distributions, a value of $\Delta\langle r^2\rangle = +1.5 \pm 0.8 \times 10^{-3}$ fm$^2$ can be deduced. (auth)

**46777** NUCLEAR SPECTROSCOPY STUDIES OF LOW-LYING STATES IN $^{99}$Tc. Zawislak, F. C.; Rogers, J. D. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). pp 151-4 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Angular correlation measurements were made for a series of cascades in the decay of $^{99}$Mo to $^{99}$Tc, from which values of the E2/M1 mixing coefficient $\delta$, as well as the spins of the various levels involved, were assigned. The value of $\delta_{140}$ obtained was used together with a measurement of the Coulomb excitation cross section of the 140-keV state to calculate a mean life of $\tau_{140} = 0.3 \pm 0.1$ nsec. A preliminary measurement of the rotation of the 41–140 keV angular correlation in a 20,000-G field, together with the above value of $\tau$, gave a value $g_{140} = 1.0 \pm 0.5$. These results compare well with the predictions of a simple core-coupling-model calculation for this nucleus. (auth)

**46778** g-FACTOR OF THE 656-keV STATE IN $^{110}$Cd. Keszthelyi, L.; Demeter, I.; Dezsi, I.; Varga, L. (Central Research Inst. for Physics, Budapest). pp 155-7 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The g-factor of the 656-keV $2^+$ state of $^{110}$Cd was measured with the internal magnetic field method to be $g = 0.30 \pm 0.12$. (auth)

**46779** g-FACTORS OF THE EXCITED STATES IN $^{124}$Te AND $^{147}$Sm. Bozek, E.; Broda, R.; Golczewski, J.; Hrynkiewicz, A. Z.; Kulessa, R.; Ogaza, S.; Rybicka, M.; Walus, W. (Jagellonian Univ., Krakow). pp 158-60 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The integral method of the $\gamma-\gamma$ directional correlation perturbed by a magnetic field was used for the g-factor determination of the 603-keV state in $^{124}$Te and the 121- and 198-keV states in $^{147}$Sm. Conventional measurements at 135° were modified by the application of the sum-coincidence technique, which gives simultaneous results for two angles +135 and −135°, being thus equivalent to the use of a three-counter setup. Besides this, in the case of $^{147}$Sm, where the cascades going through the two investigated states have the same total energy, the sum-coincidence method enables one to perform the g-factor measurements for both states simultaneously. (auth)

**46780** MAGNETIC MOMENTS OF THE FIRST EXCITED STATE IN $^{133}$Cs AND $^{129}$Xe BY THE MOESSBAUER EFFECT. Campbell, L. E.; Perlow, G. J.; Sandstrom, N. C. (Argonne National Lab., Ill.). pp 161-3 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect in an external field of 77.65 kG was used to determine the magnetic moment of the first excited states in $^{133}$Cs and $^{129}$Xe. The results are $\mu_{ex}(^{133}Cs) = 3.44 \pm 0.04$ nm and $\mu_{ex}(^{129}Xe) = +0.68 + 0.30$ nm. (auth)

**46781** ON THE IONIC STATE OF $^{143}$Pr FROM THE DECAY OF $^{143}$Ce. Tandon, P. N.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). pp 164-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

There is considerable confusion regarding the stable ionic state of $^{143}$Pr produced in the $\beta$ decay of $^{143}$Ce. This directly affects the paramagnetic correction that has to be applied in the determination of the magnetic moment of the first excited state of $^{143}$Pr at 57 keV. In the present work, the integral reversed field method of PAC is applied to the 293-57 keV $\gamma$-ray cascade, with the source in the cubic $CeO_2$ form used as well as dilute $CeCl_3$ solution. It is observed that the $CeO_2$ source gives unperturbed correlation when

the attenuation coefficient $G_2 = 0.80 \pm 0.04$ for $CeCl_3$. From the values of $G_2$ $g\beta$ deduced from the observed rotation $\omega\tau$ for both the sources, it is concluded that the $Ce^{4+}$ in $CeO_2$ leads to the 4+ state of Pr which is stable for at least ≈ 6 nsec, while $Ce^{3+}$ in $CeCl_3$ leads to the $3^+$ state of Pr. From this, the value of the g-factor of the 57-keV state of $^{143}Pr$ is found to be $g = 1.075 \pm 0.140$ ($CeCl_3$ source) and $g = 1.06 \pm 0.17$ ($CeO_2$ source). (auth)

**46782** MEASUREMENT OF g-FACTORS OF $^{156}Gd$ BY PERTURBED ANGULAR CORRELATIONS USING HYPERFINE FIELDS. Weitsch, A.; Walter, H. K. (Technische Hochschule, Darmstadt, Ger.). pp 167-71 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

By integral perturbed $\gamma$-$\gamma$ angular correlation, the g-factors of a two-quasi particle state at 1513 keV and the $4^+$ state of the ground-state rotational band in $^{156}Gd$ were measured: $g^{4+}(1513\ keV) = +0.78 \pm 0.05$, $g_R^{4+} = 0.37 \pm 0.05$. The internal field of Gd in Tb metal at 77°K was found to be $H = -192 \pm 16$ kOe. The half-lives of the mentioned states were redetermined: $T_{\frac{1}{2}}(289\ keV) = 0.115 \pm 0.003$ nsec and $T_{\frac{1}{2}}(1513\ keV) = 0.190 \pm 0.006$ nsec. Radioactive sources of $^{156}Tb$ were prepared by $^{159}Tb$ ($\gamma$,3n) and $^{156}Gd$(d,2n). Some experimental improvements concerning a four-detector apparatus are mentioned. The classification of the 1513-keV state is discussed. (auth)

**46783** NUCLEAR MOMENTS OF THE 75-keV STATE IN $^{161}Dy$. Crecelius, G.; Quitmann, D. (Technische Hochschule, Darmstadt, Ger.). pp 172-7 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The hyperfine structure of the 75-keV transition in $^{161}Dy$ was observed in a Moessbauer experiment, with Dy-Al-garnet and Dy-metal used as absorbers at 4.2°K. The source employed, $^{161}Tb$ in cerium oxide, emits an unsplit line at 4.2°K. For the spin, $I_{75} = 3/2$ and for the ratios of the g-factors and of the spectroscopic quadrupole moments $g_{75}/g_g = 1.40 \pm 0.04$ and $Q_{75}/Q_g = 0.56 \pm 0.04$, respectively, were obtained. (auth)

**46784** MOESSBAUER EFFECT AND NUCLEAR MOMENTS OF THE 75-keV STATE OF $^{161}Dy$ AND THE 81-keV STATE OF $^{162}Dy$. Henning, W.; Heunemann, D.; Weber, W.; Kienle, P.; Koerner, H. J. (Technische Hochschule, Munich). pp 178-82 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect of the $\gamma$ rays from the 74.5-keV state of $^{161}Dy$ and the 80.7-keV state of $^{162}Dy$ was investigated. From hyperfine splitting patterns the magnetic moments $\mu(75\ keV) = 0.39 \pm 0.04$ nm, $\mu(81\ keV) = +0.74 \pm 0.08$ nm and the quadrupole moment $Q(75\ keV) = +(1.4 \pm 0.2)$ b were determined. For the odd-neutron nucleus $^{161}Dy$, an effective spin g factor $g_{s,eff} = 0.76\, g_{s,free}$ is deduced for the 75-keV level. (auth)

**46785** THE g-FACTOR OF THE 496-keV LEVELS IN $^{183}Re$. Gerdau, E.; Sell, W.; Auerbach, K.; Braunsfurth, J. (Institut fuer Experimentalphysik, Hamburg). pp 183-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The g-factor and the half-life of the 496-keV, $9/2^-[514]$ Nilsson level in $^{183}Re$ were measured to be $g = 1.18(7)$ and $T_{\frac{1}{2}} = 7.89(16)$ nsec. The results are discussed in the Nilsson scheme. (auth)

**46786** g-FACTORS OF COULOMB-EXCITED STATES OF NUCLEI IN ALLOYS. Keszthelyi, L.; Demeter, I.; Szoekefalvi-Nagy, Z.; Varga, L. (Central Research Inst. for Physics, Budapest). pp 192-8 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

In $Fe_{2.92}$ $Pt_{1.08}$ alloy, various Pt states were Coulomb excited. The known g-factor of the 329-keV state of $^{194}Pt$ was used to evaluate the internal field at Pt nuclei after Coulomb excitation. The value $H = 1.0 \times 10^6$ G was obtained. Measuring the $\gamma$ radiation with a Ge(Li) detector of 2.5 $cm^3$, the 212- and 241-keV $\gamma$ radiations of $^{195}Pt$, the 320-keV $\gamma$ radiation of $^{51}V$ in $Fe_{95.5}$ $V_{4.5}$ alloy, and the radiations from the decay of the 366-keV state of $^{57}Fe$ are well measurable. (auth)

**46787** THE g-FACTOR OF THE FIRST EXCITED STATE OF $^{196}Pt$. Beraud, R. (Univ., Lyon); Berkes, I.; Daniere, J.; Levy, Michele; Marest, G.; Rougny, R.; Bernas, H.; Spanjaard, D. pp 199-207 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

By the integral rotation method, the g-factor of the first excited state of $^{196}Pt$ was determined using the internal magnetic field of dilute iron alloy to be $g = 0.292 \pm 0.036$. Using the recent internal field and lifetime values, it is found that the reevaluated g-factor of $^{192}Pt$, $^{194}Pt$ and $^{196}Pt$ first excited states are in good agreement with vibrational-rotational model calculations. (auth)

**46788** MAGNETIC MOMENTS OF THE FIRST EXCITED $2^+$ STATES IN EVEN Hg ISOTOPES. Kalish, R. (Massachusetts Inst. of Tech., Cambridge); Grodzins, L.; Murnick, D. E.; Borchers, R. R.; Herskind, B.; Bronson, J. D. pp 208-13 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Larmor precession angles for the Coulomb excited first $2^+$ states of $^{198}Hg$, $^{200}Hg$, $^{202}Hg$, and $^{204}Hg$, implanted into a polarized iron lattice, were determined by the ion implantation perturbed angular correlation technique (IMPACT). The effective magnetic field on $^{198}Hg$ is a factor of 2 smaller than the effective field observed by using radioactive sources. The present results, normalized to the known g-value of the $2^+$ state in $^{198}Hg$, $g = 0.55 \pm 0.11$ measured in an external magnetic field, yield g-values for the $2^+$ states of $^{200}Hg$, $^{202}Hg$, and $^{204}Hg$ of $0.73 \pm 0.27$, $0.77 \pm 0.23$, and $0.29 \pm 0.15$, respectively. The g-values for the $2^+$ states of $^{198}Hg$ and $^{200}Hg$ are greater than Z/A, in accord with the predictions of Kumar and of Covello. A sharp decline in g-values of $2^+$ states, between $^{200}Hg$ and $^{202}Hg$, predicted by Kumar, is not observed. A large decrease in g-values of $2^+$ states appears to occur between $^{202}Hg$ and $^{204}Hg$. (auth)

**46789** EVIDENCE FOR AN ANOMALOUS QUADRUPOLE MOMENT OF THE 86.5-keV STATE IN $^{155}Gd$. Blumberg, H.; Persson, B.; Bent, M. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. pp 252-5 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The quadrupole interactions of the 105-keV, 86.5-keV, and ground states in $^{155}Gd$ were studied in Moessbauer transmission experiments with the results $|Q(86.5)/Q(0)| = 0.18 \pm 0.10$, $Q(105)/Q(0) = 1.0 \pm 0.2$, and $I(105) = 3/2$. The results indicate strong mixing of the 86.5-keV state and $I(86.5) = 5/2$. (auth)

**46790** ANISOTROPIC HYPERFINE INTERACTIONS IN $Fe^{2+}$ SALTS. Johnson, C. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 226-35 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The $^{57}Fe$ Moessbauer spectra were measured for single crystals of two $Fe^{2+}$ salts, $FeSiF_6 \cdot 6H_2O$ and $FeCl_2 \cdot 4H_2O$, which were magnetized at 4.2°K in fields of up to 30 kG applied in various directions relative to the crystal axes, and the components of the magnetic hyperfine interaction tensor were deduced from the data. From the observed anisotropy an average effective value of $\langle r^{-3} \rangle$ and the value of the isotropic contact part $H_s$ of the hyperfine field were deduced. Assuming that the spin and charge densities of the ion have the same radial distribution, a reassessment is made of the quadrupole moment of the 14.4-keV state of $^{57}Fe$. (auth)

**46791** NUCLEAR MOMENTS OF EXCITED STATES IN $^{155}Gd$ AND $^{156}Gd$. Tomblin, F. F.; Barrett, P. H. (Univ. of California, Santa Barbara). pp 245-51 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Moessbauer effect experiments were carried out in three excited states of $^{155}Gd$ and the first excited state of $^{156}Gd$. $^{155}Eu$, diffused into $YbAl_3$, provided a sufficiently unbroadened source for the observation of hyperfine splitting in the 86.5-keV level of $^{155}Gd$. Hyperfine splitting was observed in $Gd_2O_3$ at temperatures from 6.5 to 77°K and indicated a spin of $3/2$ for the excited state. The ratio of the ground-state quadrupole moment to the excited state moment is $2.89 \pm 0.10$. A $GdFe_2$ absorber was used to deter-

mine the g-factor of the 86.5-keV level as $-0.220 \pm 0.010$. Moessbauer spectra were also observed in the 105.3- and 60.0-keV levels of $^{155}$Gd; however, the structure was not sufficiently well resolved to determine nuclear moments. Moessbauer spectra of $^{156}Gd_2O_3$ allowed the observation of hyperfine splitting due to the interaction of the quadrupole moment of the 89.0-keV level in $^{156}$Gd. The ratio $Q_{156}(89.0)/Q_{155}(0) = 1.19 \pm 0.08$ was determined. (auth)

**46792** MAGNETIC HYPERFINE FIELD, NUCLEAR g-FACTOR, AND SPIN–LATTICE RELAXATION FOR $^{125}$Sb IN IRON FROM NUCLEAR ORIENTATION-NMR. Barclay, J. A.; Brewer, W. D.; Matthias, E.; Shirley, D. A. (Univ. of California, Berkeley). pp 902-7 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The technique of nuclear orientation NMR was used to measure the magnetic hyperfine field, nuclear g-factor, and spin-lattice relaxation time for $^{125}$Sb in Fe. (D.C.W.)

**46793** EFFECT OF PRESSURE ON HYPERFINE FIELDS IN THE DECAY OF GASEOUS $^{127}$Xe. Gygax, F. N.; Egger, J.; Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 948-51 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The anisotropy of the $\gamma$-$\gamma$ directional correlation of the 172- to 203-keV cascade in the decay of gaseous $^{127}$Xe has been measured as a function of pressure of xenon buffer gas. In the pressure range studied, between 1 torr and 60 atm, very large variations of the anisotropy are observed. The effect is produced by changes in the hyperfine interaction during the lifetime of the intermediate state, due to collisions between iodine ions and atoms of the buffer gas. In the low-pressure range, the anisotropy is independent of pressure. Between 30 and 90 torr, anisotropies substantially below the hard-core value are observed. Upon increasing the pressure over three more decades, the anisotropy slowly rises, reaching at 60 atm a value close to that observed earlier for $^{127}$Xe in an aluminum foil. (auth)

**46794** INFINITE DILUTION RESONANCE ABSORPTION INTEGRALS OF HAFNIUM. Rogers, J. W.; Scoville, J. J. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng., 33: 350-2(1968).

Measurements were made of infinite dilution resonance absorption integrals of natural hafnium and its separated stable isotopes were made by static reactivity techniques. Unexplained discrepancies between the results and earlier experimental results were noted. (J.W.R.)

**46795** PARITY NONCONSERVATION IN THE BETA DECAY OF $^{129}$Te, STUDIED BY THE MOESSBAUER EFFECT. de Waard, H.; Heberle, J.; Schurer, P. J.; Hasper, H.; Koks, F. W. J. (Univ. of Groningen, Netherlands). pp 329-40 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

An experiment is described in which asymmetry in the magnetic hyperfine structure of the 27.7-keV gamma line in $^{129}$I is observed in coincidence with preceding beta particles. A source of $^{129m}$Te implanted in a magnetized iron foil is used. From the experiment, values are derived for the beta-decay parameter B in the expression $P(m^*) \propto 1 + B(v/c)(m^*/I^*)$ for the populations of the magnetic sublevels of the 27.7-keV state $(m^*, I^*)$ in $^{129}$I. For a positive sign of the E2/M1 matrix element ratio $\delta$ of the 27.7-keV transition, a value of B that is in agreement with the theoretical value B = 1 to be expected for a Gamow–Teller transition on the basis of the theory of beta decay with two component neutrinos is obtained. (auth)

**46796** DETERMINATION OF THE MEAN LIFE OF THE 77-keV STATE IN $^{197}$Au AND OF THE 140-keV STATE IN $^{99}$Tc BY MOESSBAUER EXPERIMENTS. Steiner, P.; Gerdau, E.; Hautsch, W.; Steenken, D. (Institut fuer Experimentalphysik, Hamburg). pp 364-9 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The mean lives of the 77-keV state in $^{197}$Au and of the 140-keV state in $^{99}$Tc were determined by interpolation of the measured effective line widths to zero effective thickness. An improved expression was used for the interpolation. The results are: $\tau$ (77-keV level of $^{197}$Au) = 2.724 (29) nsec and $\tau$ (140-keV level of $^{99}$Tc) = 277 (14) psec. An independent value for $^{197}$Au of $\tau$ (77-keV level of $^{197}$Au) = 2.736 (29) nsec was derived from a Moessbauer transmission curve with an absorber of effective thickness of 25. (auth)

**46797** TEST OF T INVARIANCE USING THE MOESSBAUER EFFECT. Zech, E.; Wagner, F.; Koerner, H. J.; Kienle, P. (Technische Hochschule, Munich). pp 314-17 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

Time-reversal invariance was tested using the Moessbauer effect of the 73-keV $\gamma$ transition of $^{193}$Ir. An upper limit for the ratio of the T-violating to the T-conserving Hamiltonian of $5 \times 10^{-3}$ was deduced. (auth)

**46798** MAGNETIC MOMENTS AND QUADRUPOLE-MOMENT RATIOS OF THE FIRST EXCITED STATES IN $^{182\ 184\ 186}$W. Persson, B.; Blumberg, H.; Agresti, D. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. pp 268-76 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The magnetic and quadrupole hyperfine interactions of the first excited $2^+$ states in even-A tungsten nuclei were studied in Moessbauer transmission experiments. With the internal field at the W nuclei in an Fe host matrix equal to 630 ± 13 kG (from NMR data), the g-factors are: $g^{182} = 0.266 \pm 0.009$, $g^{184} = 0.296 \pm 0.009$, $g^{186} = 0.316 \pm 0.009$. These results are in good agreement with recent calculations of Prior and Nilsson. For the diagonal matrix elements of the quadrupole-moment operator, $Q_{22}^{182} : Q_{22}^{184} : Q_{22}^{186} = 1 : 0.94 \pm 0.02 : 0.88 \pm 0.01$ was obtained. These ratios are nearly equal to the ratios of the transition matrix elements, $Q_{02}^{182} : Q_{02}^{184} : Q_{02}^{186} = 1 : 0.95 \pm 0.02 : 0.90 \pm 0.01$, evaluated from recent Coulomb-excitation data. These results are in good agreement with the rotational model. The microscopic calculations of Kumar and Baranger seem to predict too large a deviation from it. (auth)

**46799** MOESSBAUER EXPERIMENTS WITH THE 93.2-keV TRANSITION IN $^{178}$Hf. Gerdau, E.; Steiner, P.; Steenken, D. (Institut fuer Experimentalphysik, Hamburg). pp 261-7 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The quadrupole hyperfine interactions of $^{178}$Hf in Hf metal, $HfO_2$, and $(NH_4)_2HfF_6$ were measured and were compared to earlier measurements with the equivalent transitions in $^{176}$Hf and $^{180}$Hf. Clear evidence for a dependence of the recoilless fraction from the angle between the crystal axis and the emission direction of the $\gamma$ quantum was found from the analysis of the $(NH_4)_2HfF_6$ spectra. (auth)

**46800** LARMOR PRECESSION FOR THE 4+ STATES IN SOME ERBIUM ISOTOPES. Deutch, B. I.; Hagemann, G. B.; Hagemann, K. A.; Ogaza, S. (Univ. of Copenhagen). pp 731-4 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

The Larmor precession for the $4^+$ states in $^{166}$Er, $^{168}$Er, and $^{170}$Er was remeasured by Coulomb-excitation technique with iron foil; the values of $\omega\tau$ are $0.60 \pm 0.05$, $0.60 \pm 0.05$, and $0.62 \pm 0.06$ rad, respectively. These results imply a higher internal magnetic field of Er in iron foil than that established earlier. (auth)

**46801** SYSTEMATIC STUDY OF NUCLEAR MOMENTS BY MOESSBAUER EFFECTS FOLLOWING COULOMB EXCITATION. Lee, Y.-K.; Eck, J. S.; Oleson, J. R.; Shnidman, R.; Walker, J. C.; Wiggins, J. W. (Johns Hopkins Univ., Baltimore). pp 675-85 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL–17800; CONF-670812.

A systematic study of nuclear moments of isotopes of rare earths was carried out by using Coulomb excitation to populate the Moessbauer levels whenever the radioactive parent was not available. Systematic trends in quadrupole moments among isotopes of gadolinium and ytterbium, and the magnetic moment among isotopes of ytterbium, are investigated. The preliminary data from a similar study of isotopes of erbium are presented along with new Moessbauer level in $^{153}$Eu. The present approach

was extended to actinides. A new Moessbauer effect was observed in $^{238}$U, which shows evidence of resolved hyperfine structure. (auth)

**46802** PERTURBED ANGULAR CORRELATION MEASUREMENTS WITH $\beta$ PARTICLES FROM $^{154}$Eu. Nielsen, K. Bonde; Deutch, B. I. (Univ. of Aarhus, Denmark). pp 727-30 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

It is demonstrated that the technique of perturbed angular correlations (PAC) can be extended to the utilization of electrons. The sources were prepared by embedding $^{154}$Eu in iron foil by means of an isotope separator. The PAC results for the 123-keV state in $^{154}$Gd are consistent when obtained either by using the 1281 $\gamma$-123 $\gamma$ or the 1855 $\beta$-123 $\gamma$ cascade, for magnetization currents varying by a factor of 15. The average ratio between the rotations of the correlation pattern is $\Delta\theta(\gamma\text{-}\gamma)/\Delta\theta(\beta\text{-}\gamma)$ = 0.96 ± 0.10, where $\Delta\theta(\gamma\text{-}\gamma)$ = 0.105 ± 0.007. Identical PAC determinations are possible with conversion electrons in an energy range ≥ 20 keV. Further results indicate that the apparent rotation of Gd and Lu in iron are similar and follow the estimated magnetization of the foil. The Lu has an effective internal magnetic field of 483 ± 60 kG in unannealed iron foil. (auth)

**46803** ANOMALOUS HYPERFINE FIELDS IN Fe HOSTS. Herskind, B. (Univ. of Wisconsin, Madison); Borchers, R. R.; Bronson, J. D.; Murnick, D. E.; Grodzins, L.; Kalish, R. pp 735-51 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

IMPACT measurements on the first 2+ states of the even isotopes $^{98,100}$Mo, $^{98-104}$Ru, $^{104-110}$Pd, $^{110-116}$Cd, and $^{120-128}$Te have indicated the presence of an anomalous hyperfine magnetic field. The effect is most pronounced for short-lived excited states, indicating that the anomalous field is time-dependent and short-lived. Most of the present measurements are consistent with a field of several mOe having a lifetime of a few psec. The most likely mechanism for the field appears to be the pickup of polarized electrons during the slowing-down process in Fe. (auth)

**46804** PROTON FISSION CROSS SECTIONS OF $^{209}$Bi, $^{235}$U, $^{238}$U, $^{237}$Np, $^{239}$Pu FOR THE PROTON ENERGIES 1 TO 9 GeV. Matusevich, E. S.; Regushevskii, V. I. Yadern. Fiz., 7: 1187-9 (June 1968). (In Russian).

Cross sections of fission by protons with energies 1-9 GeV are obtained for a number of elements. The measurements are fulfilled by means of the inner proton beam at the proton synchrotron. The number of fission events was determined from the traces of fragments in glass. The number of protons was determined from the reaction $^{27}$Al(p,3pn)$^{24}$Na. The obtained results are compared with previous data. (auth)

**46805** INDIRECT MEASUREMENT OF NEUTRON EMISSION FROM FISSION FRAGMENTS. Schmitt, H. W.; Lide, R. W.; Pleasonton, F. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 63: 237-46(Aug. 15, 1968). (ORNL-P-3698).

An experiment to determine indirectly the average number of neutrons emitted by fission fragments as a function of fragment mass and total kinetic energy is described. The method is based on the measurement of both fragment kinetic energies and the velocity of one of the fragments, and is particularly applicable to medium or high excitation cases where direct neutron counting is difficult or impractical. Details of the analysis of such an experiment are given, and results for $^{252}$Cf spontaneous fission are shown. (auth)

**46806** NUCLEAR PROPERTIES OF $^{246}$Am AND $^{247}$Am. Fields, P. R.; Ahmad, I.; Sjoblom, R. K.; Barnes, R. F.; Horwitz, E. P. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 30: 1345-52(July 1968).

$^{247}$Am and a high-spin isomer of $^{246}$Am were produced by $^{4}$He irradiations of $^{246}$Pu. The beta decay half-lives were found to be 39 ± 3 and 20 ± 4 min for $^{246}$Am and $^{247}$Am, respectively. Gamma rays of 99.5, 127.4, 153.5, 205, 630, 680, 757, 782, and 835 keV were associated with the decay of $^{246}$Am; and 227- and 285-keV $\gamma$ rays were emitted by $^{247}$Am. The 99.5-, 153.5- and 205-keV $\gamma$ rays are transitions between members of the ground-state band. Coincidence studies established levels at 1181 and 1053 keV, the former being an 8$^-$ state and the latter having a spin of 6 or 7. The $\gamma$ rays of energy 127.4, 630, 782, and 835 keV are not definitely assigned. (auth) (UK)

**46807** TECHNIQUES DEVELOPED FOR MEASURING DIRECTIONAL CORRELATIONS BETWEEN X RAYS AND CONVERSION ELECTRONS OR GAMMA RAYS IN THE STUDY OF $^{139}$Ce. Measel, Paul Russell. Columbus, Ohio, Ohio State Univ., 1967. 131p.

Thesis.

A lithium-drifted solid-state detector was used in the design of a coincidence system which permitted coincidence measurements between gamma rays, conversion electrons and x rays down to 2 keV. In order to determine the usefulness of the system and to develop some experimental techniques, an investigation was made of directional correlation between conversion electrons and x rays as well as between gamma rays and x rays emitted from $^{139}$Ce. (J.W.R.)

**46808** EXPERIMENTAL STUDY OF THE T = $T_z$ STATES IN $^{90}$Zr VIA A ($^3$He,d) REACTION. Vourvopoulos, George. Tallahassee, Fla., Florida State Univ., 1967. 123p.

Thesis.

$^{89}$Y($^3$He,d)$^{90}$Zr data taken with the Oak Ridge Isochronous Cyclotron with $E^{lab}_{He}$ = 25 MeV is analyzed. Previously seen states at 0.0, 1.76, 2.32, 2.73 MeV are used as a check on the analysis. Six $l_p$ = 1 states are found in the vicinity of 4.5 MeV excitation, and this is plausible only if the ground state of $^{89}$Y is not pure $p_{\frac{1}{2}}$. 37 states are observed between 5.08-8.12 MeV excitation with $l_p$ = 2 and $l_p$ = 0. These states are considered to be the $T_<$ = $T_z$ single particle-hole states of the $p^{-1}_{\frac{1}{2}}d_{\frac{5}{2}}$, $p^{-1}_{\frac{1}{2}}s_{\frac{1}{2}}$, and $p^{-1}_{\frac{1}{2}}d_{\frac{3}{2}}$ proton configuration in $^{90}$Zr. The possibility exists that there are some additional states of the $p^{-1}_{\frac{1}{2}}d_{\frac{5}{2}}$ proton configuration higher than 8.12 MeV. The energy separation between the centroid of each of the $T_<$ = $T_0$-½ groups and the corresponding analogues with $T_>$ = $T_0$+½ is found to be approximately 7 MeV. The strength of the isobaric-spin dependent potential, responsible for the splitting of the $T_>$ from the $T_<$ states is calculated to be 148 MeV. Spectroscopic factors are extracted and are compared to theoretical sums of spectroscopic factors. The total number of $T_<$ states seen is in good agreement with the number calculated from considerations of "core-polarization" states mixed with the actual $T_<$ states through nuclear interactions. (Disser. Abstr.)

**46809** A COINCIDENCE TECHNIQUE FOR THE NONDESTRUCTIVE MEASUREMENT OF THE NEUTRON CAPTURE RATE OF A $^{236}$U-FOIL IN A ZERO POWER FAST REACTOR. Hall, Ronald James. Columbus, Ohio, Ohio State Univ., 1967. 133p.

Thesis.

A purely physical technique for measuring the neutron capture rate of a $^{236}$U foil in a zero power fast reactor has been developed. Capture in $^{236}$U was measured by observation of $^{237}$U decay. The rate of $^{237}$U decay was determined with an absolutely calibrated gamma-gamma coincidence system. Germanium detectors were used in the coincidence system. The $^{236}$U neutron capture rate was measured in ZPR-9 Assembly 18, located at Argonne National Laboratory, with a standard error of less than 3%. The ratio of the number of captures by $^{236}$U to the number of fissions of $^{235}$U at the irradiation position was found to be 0.248 with a standard error of approximately 4%. Methods for measuring the neutron capture rates of $^{240}$Pu, $^{242}$Pu, $^{239}$Np, and $^{233}$Pa in a fast reactor are proposed. (Disser. Abstr.)

**46810** ANGULAR DISTRIBUTION OF GAMMA RAYS FROM THE FISSION OF $^{235}$U INDUCED BY 14-MeV NEUTRONS. Jeki, Laszlo; Kluge, Gyula; Lajtai, Albert. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 16: 213-18(1968). (In Hungarian).

The intensity of the gamma radiation following the 14-MeV neutron-induced fission of $^{235}$U was measured at angles of 90 and 174° relative to the flight path of the fission fragments. At both angles, the flight path of the bombarding neutrons and that of the fission fragments were found to be lying in almost the same direction. Thus, the angular momentum of the fast neutrons was perpendicular to the fission axis. The intensity of gamma rays measured in the direction of fission fragment motion was found to be higher than that measured normal to their flight path. This anisotropy is larger than that observed for thermal neutron-induced fission. The anisotropy was evaluated from the measured data as $A = I_{174°}/I_{90°} = 1.32 \pm 0.18$. Applying kinematic corrections for the motion of fragments during their emission of gamma rays, the anisotropy transformed into center-of-mass system was evaluated as A = 1.37 ± 0.19, from which the average angular momentum of the fission fragments can be estimated as about 15 units. (auth)

**46811** RADIOACTIVE DECAY OF $^{117}$Te. Vartanov, N. A.; Dmitriev, P. P.; Krasnov, N. N.; Samoylov, P. S. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr., No. 1, 233-7(1964). (In Russian).

To determine more accurately the decay scheme, a study was made of the $\gamma$ spectrum of $^{117}$Te obtained via the reaction $^{114}$Sn($\alpha$,n). The measurements were made with a scintillation gamma spectrometer with NaI(Tl) crystal measuring 40 × 40 mm. The energy resolution for the 662-keV $\gamma$ line was 8.5%. Careful calibration of

the crystal efficiency was carried out in the energy range 265 to 2760 keV. The following values were obtained for the energies (in keV) and for the relative γ-line intensities: 730 ± 10 (100), 940 ± 15 (4.5 ± 3), 1080 (5.5 ± 1.2), 1310 ± 20 (14 ± 2), 1740 ± 25 (16.5 ± 1.5), and 2230 ± 25 (17.4 ± 2). The data obtained confirm in general outline the decay scheme proposed by Fink et al. (ATD)

**46812** BETA SPECTRA OF THE $1^- \rightarrow 2^+$ TRANSITIONS OF $^{186}$Re AND $^{188}$Re. Andre, S.; Liaud, P. (Univ., Grenoble, France. CEN, Grenoble, France). J. Phys. (Paris), 29: 395-401(May-June 1968). (In French).

The β spectra of the $1^- \rightarrow 2^+$ transitions leading to the first excited states of $^{186}$Os and $^{188}$Os were measured by using a magnetic β-spectrometer and β-γ coincidences. For the first transition, a deviation from the statistical shape was observed which is in agreement with the measurement of Porter et al. A similar deviation was observed for the other transition. (auth)

## Nuclear Theory

*Refer also to abstracts 46461, 46495, 46566, 46698, 46714, 46718, 46724, 46729, 46731, 46734, 46748, 46749, 46755, 46766, 46772, and 46802.*

**46813** (ANL-Trans-634) SOME SHELL EFFECTS IN TRANSURANIUM NUCLEI. Strutinskii, V. M.; Muzychka, Yu. A. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from pp 51-64 of Trudy Mezhdunarodnoi Konferentsii po Fizike Tyazhelykh Ionov Dubna, 13-19 Oktyabrya 1966 G. Vypusk 2. Sintez i Issledovanie Svoistv Izotopov Transuranovykh Elementov. 10p. Dep. CFSTI.

Calculations were made for shell effects on the deformation energy of nuclei of some transuranium elements and superheavy nuclei. The Nilsson level scheme and the linear approximation for nucleon levels in deformed nuclei were used. (J.W.R.)

**46814** (IFA-FT-68) ON A COUPLING BETWEEN QUADRUPOLE AND OCTUPOLE PHONON STATES. Raduta, A. A.; Sandulescu, A. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 26p. Dep.

The $1^-$, $1^-$, $3^-$, $4^-$, $5^-$ quintet arising from coupling of quadrupole and octupole vibrations was previously studied taking into account all the independent terms of third and fourth degree in momentum that were invariant under inversions and rotations. A reformulation is presented in which the cubic term in momentum in the Hamiltonian is excluded. The quintet shift and the electromagnetic transition rates to the first $2^+$, $3^-$ excited states are evaluated by linearizing the motion equations containing only the anharmonic terms arising from quadrupole interaction. (D.C.W.)

**46815** (JINR-E7-3942) FISSION OF EXCITED NUCLEI. Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 21p. Dep.

Nuclear fission at an excitation energy of more than 50 MeV was investigated. It is shown that the statistical theory determines a nuclear state at the saddle point rather well, but appears to be inapplicable for describing the process at the scission point. This conclusion is based on the experiments on mass and charge distributions of fission fragments for nuclei in the wide $Z^2/A$ range. (auth)

**46816** (JINR-P4-3898) ANHARMONIC EFFECTS IN NUCLEI OF THE TRANSITION REGION. Dzholos, R. V.; Fainer, U. M.; Solov'ev, V. G.; Zheleznova, K. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 6p. (In Russian). Dep.

The admixtures of the two-phonon states to the lowest one-phonon states in some even–even nuclei of the transition region were considered. It was shown that these admixtures are not large but that they increase when approaching spherical nuclei. (auth)

**46817** (JINR-P4-3934) MAGNETIC DIPOLE INTERACTIONS IN DEFORMED NUCLEI. Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 25p. (In Russian). Dep.

The spin polarization effects in odd-mass deformed nuclei are considered using the Tamm–Dancoff method. Expressions for the amplitudes of three-quasi particle admixtures to one-quasi particle states and the dispersion equation for the energy shift of single-particle levels due to the magnetic dipole interactions are derived. The theory is applied to calculate the intrinsic dipole magnetic moments of rare-earth nuclei. (auth)

**46818** (JINR-P4-3941) ELASTIC ELECTRON SCATTERING BY NUCLEI AT AN ARBITRARY CHARGE DENSITY DISTRIBUTION. Luk'yanov, V. K.; Petkov, I. Zh.; Pol, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 16p. (In Russian). Dep.

In a high-energy approximation ($E \gg V$), a method is considered for calculating the cross section of the electron scattering by nuclei with an arbitrary Fermi-like distribution of the charge density. The method implies an expansion of the density over the orthonormalized function system, produced from the derivatives of the Fermi density, and the use of their pole singularities for the amplitude calculation. Good agreement with exact cross-section calculations, made with the Dirac equation, has been obtained. An example is given of using the method for the analysis of the experimental data. (auth)

**46819** (NRL-6733) A TABLE OF CENTRAL-FORCE GEOMETRICAL COEFFICIENTS ASSOCIATED WITH TALMI INTEGRALS FOR USE IN CALCULATING NUCLEAR TWO-BODY MATRIX ELEMENTS USING HARMONIC OSCILLATOR WAVE FUNCTIONS. Langworthy, J. B.; Podgor, S. (Naval Research Lab., Washington, D. C.). Apr. 8, 1968. 61p.

In calculating nuclear two-body matrix elements using harmonic oscillator wave functions, the radial parts give Talmi integrals and the angular parts may be done by Racah algebra, yielding the geometrical coefficients tabulated here. This table is calculated from the harmonic oscillator transformation brackets and B coefficients of Moshinsky. The table is applicable to the calculation of central-force matrix elements for nuclides containing up to 70 nucleons of a single species and is accurate to at least seven significant figures. (auth)

**46820** (UCSD-10-P-11-75) INTERMEDIATE STRUCTURE IN RESONANCES. Payne, Gerald Lew (California Univ., La Jolla, San Diego). Dec. 1967. Contract AT-11-1-GEN-10. 186p. Dep. CFSTI.

Thesis.

The effects of two-particle-one-hole states on the elastic cross section for the scattering of neutrons from nuclei are studied. It has been suggested that these states are responsible for the intermediate resonances observed in the averaged cross section. The intermediate resonances are observed when the averaging width is larger than the widths and spacings of the compound nucleus states but smaller than the width of the structure in the optical model cross section. It is shown that if these states are to be observed experimentally, their width due to decay back into the initial single particle state must be less than their width for decay into more complicated configurations. Also, their spacing must be larger than their widths. The self-consistent K-matrix methods developed by Brueckner are used to evaluate the widths for these states in order to see when the above conditions are satisfied. The calculations are first done for nuclear matter. For the heavy nuclei, where nuclear matter is a good representation, the two conditions are not satisfied. Consequently, for heavy nuclei the resonances due to the two-particle-one-hole states should not be observable. The widths for a number of spherical nuclei are calculated using a shell model basis. For light nuclei and doubly magic nuclei the resonances due to the two-particle-one-hole states are observable. For medium weight nuclei ($A \approx 50$) the states are observable only at low energies. In heavy nuclei the resonances are too damped to be observed, in agreement with nuclear matter results. (auth)

**46821** INNER PRODUCT FOR RESONANT STATES AND SHELL-MODEL APPLICATIONS. Romo, William J. (Univ. of Wisconsin, Madison). Nucl. Phys., A116: 618-36(1968).

A generalization of the standard inner-product integral is developed, which allows one to treat resonant states on an equal footing with bound states. The resonant and bound states are shown to form an orthonormal set with respect to the generalized inner product. Near a complex resonance energy $E_s$ of the Hamiltonian H, the Green function $(E + i\epsilon - H)^{-1}$ is shown to be approximately equal to $|s)(s|/(E - E_s)$, where $|s)$ is the normalized (in terms of the new inner product) resonance state. This is exactly the same form as the leading term in the Green function expansion about a bound state pole. This feature can be exploited in a reformulation of the MacDonald or Weidenmüller shell-model theory of nuclear reactions. The new formalism also has possible applications to giant resonance problems, stripping to unstable final state or any other problem where resonances play an important part. (auth)

**46822** VALIDITY OF THE EXPONENTIAL TIME DECAY LAW OF NUCLEAR ALPHA EMITTERS. Jeukenne, J. P. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 37: 32-8(1968). (In French).

The validity of the exponential decay law used in the shell model theory of alpha emission is discussed by means of the solution of the time-dependent Schroedinger equation given in a previous

paper. Exponential decay is shown to suffer rather strict limitations associated with the quantum-mechanical spreading of wave packets. (auth)

**46823** THREE-BODY MODEL OF THE DEUTERON OPTICAL POTENTIAL. Ziegler, Jerry Louis. Tallahassee, Fla., Florida State Univ., 1967. 186p.

Thesis.

Deuteron scattering from complex nuclei was examined within the framework of a three-body model. The nuclear potential for each nucleon in the deuteron was represented by the optical model potential used in nucleon scattering from the same target nucleus. The three-body Schrodinger equation was expanded into a perturbation series. The first-order term was qualitatively identified as the local potential corresponding in magnitude with the simple sum of the nucleon optical potentials. Second-order terms were calculated using a high-speed computer in order to try and derive an unambiguous magnitude for the effective deuteron optical potential. Using physical values for the cases of $^{56}$Fe and $^{65}$Cu, the calculated deuteron potential was found to be affected by as much as 25% by the second-order terms. It was found that the second-order terms for each partial wave decreased relative to first order terms as the deuteron energy was increased. The results obtained suggested that the deuteron potential for 10- to 20-MeV deuterons has a magnitude of about 130 MeV for a radius parameter of about 1.15 F. The nonlocality and partial-wave dependence of the second-order terms was investigated and was found to be very complicated so that no general trends other than a strong parity dependence were observed. (Diss. Abstr.)

**46824** SIMILARITY BETWEEN NEUTRON AND PROTON SINGLE PARTICLE STATES AT THE SAME MASS NUMBER. Cohen, B. L. (Univ. of Pittsburgh). Phys. Lett., 27B: 271-3(Aug. 5, 1968).

It is shown that in most cases, the relative positions of neutron and proton single particle states are very similar at the same mass number, much more similar than is either at different A with the exception of A = 49. (auth)

**46825** SELF-CONSISTENT TREATMENT OF COLLECTIVE VIBRATIONS IN TERMS OF BOSON EXPANSIONS. Soerensen, Bent (Kyoto Univ. NORDITA, Copenhagen). Progr. Theor. Phys. (Kyoto), 39: 1468-86(June 1968).

Earlier, a rapidly converging boson series expansion of fermion pair operators was suggested, and application to collective vibrations was discussed. This theory is now extended by introducing a self-consistency requirement in the determination of the structure of the boson vacuum to be used. In this way one is allowed to use a basic fermion representation which do not correspond to the actual shape of the system. Such a possibility becomes important in cases, where the shape of the system is not known beforehand, such as in the region of transition between spherical and deformed shape, and quite generally it allows a unified description of systems with different equilibrium shapes. (auth)

**46826** INSTABILITY OF SPHEROIDAL SUPER-HEAVY NUCLEI. Takahashi, Kohji (Waseda Univ., Tokyo); Kajita, Isamu; Yamada, Masami. Progr. Theor. Phys. (Kyoto), 39: 1607-8 (June 1968).

It is shown that a prolate spheroidal super-heavy nucleus is not in equilibrium in the liquid drop model. Only the surface and the Coulomb terms are questioned regarding the incompressible deformation. One can determine the equilibrium shape by making the total energy stationary with the condition of constant volume. It is concluded that within the framework of the liquid drop model, super-heavy nuclei cannot exist in the prolate spheroidal configuration. (J.F.P.)

**46827** ISOMER SHIFTS AND MAGNETIC HFS COUPLING IN MUONIC ATOMS. Daniel, H. (Max-Plack-Institut fuer Kernphysik, Heidelberg. CERN, Geneva). Naturwissenschaften, 55: 339-40(July 1968).

A possible explanation in terms of magnetic hfs effects is given for the disagreement between the Mössbauer effect and nuclear gamma rays in determining isomer shifts in muonic atoms. (J.W.R.)

**46828** MAGNETIC MOMENTS IN EVEN-A SINGLE CLOSED SHELL NUCLEI. Lombard, R. J. (Univ. of California, La Jolla, San Diego). pp 97-105 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Magnetic moments of excited states were calculated in even-A single closed shell nuclei. The estimation is based on the quasiparticle description of nuclear states. The agreement with the few existing experimental values is relatively good. (auth)

**46829** SPIN-POLARIZATION EFFECT IN DEFORMED ODD MASS NUCLEI. Bochnacki, Z. (Inst. of Nuclear Physics, Krakow); Ogaza, S. pp 106-15 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

A description of the spin-polarization effect in deformed odd-mass nuclei is presented. The basic assumptions are discussed, and a comparison is made of theoretical estimates of the effect with experimental evidence obtained from magnetic properties and allowed unhindered beta transition rates. (auth)

**46830** STATIC QUADRUPOLE MOMENTS FROM COULOMB EXCITATION. Winther, Aage (California Inst. of Tech., Pasadena). Contracts Nonr-220(47); AT(04-3)-63. pp 217-25 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

As indicated by an adiabatic treatment of Coulomb excitation, the main effect of the static quadrupole moment in the Coulomb excitation experiments performed up to now is associated with a hyperfine splitting and not with a reorientation. (auth)

**46831** HYPERFINE STRUCTURE AND NUCLEAR RADIATIONS. Proceedings of a Conference Held at Asilomar, Pacific Grove, California, August 25-30, 1967. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Company, 1968. 1110p. $25.00. (In English and German). (UCRL-17800; CONF-670812).

Separate abstracts were prepared for 95 of the 102 papers included. The other seven papers have previously appeared in NSA (21: 44720, 46772; and 22: 3715, 3761, 5796, 26957, 36977). (D.C.W.)

*For abstracts of individual papers see: 45785, 46062, 46218–46224, 46232–46234, 46237, 46249–46267, 46269–46273, 46724–46726, 46744–46747, 46750–46753, 46774–46793, 46795–46803, 46828–46830, 46832–46835, and 46837–46846.*

**46832** NUCLEAR MOMENTS. Sorensen, R. A. (Carnegie-Mellon Univ., Pittsburgh). pp 13-26 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

A survey of developments in the measurement and theory of nuclear moments is presented. (D.C.W.)

**46833** NUCLEAR INFORMATION OBTAINED WITH THE MOESSBAUER EFFECT. Kienle, P. (Technische Hochschule, Munich. Argonne National Lab., Ill.). pp 27-45 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Recent applications of the Moessbauer effect in nuclear spectroscopy are reviewed. From measurements of $\gamma$-ray hyperfine spectra the following nuclear data have been deduced: spins and g-factors of excited states; absolute values, ratios and relative phases of $\gamma$ transition matrix elements; ratios of quadrupole moments of ground states and excited states; and ratios and absolute values of the change of mean squared nuclear charge radii $\Delta\langle r^2\rangle$. Systematic results concerning magnetic properties of rotational states and $\Delta\langle r^2\rangle$ for both single-particle and collective transitions are discussed. (46 references) (auth)

**46834** HYPERFINE STRUCTURE OF MUONIC X RAYS. Wu, C. S. (Columbia Univ., New York). pp 46-64 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The theoretical implications of the hyperfine structure of muonic x rays on nuclear structure are briefly reviewed. The recent hyperfine muonic x-ray measurements on strongly deformed nuclei as well as on nuclei in the transition region are presented. The variations of charge distribution parameters (c,a) and the deformation parameters ($\beta$,$\beta'$) of the nuclei as obtained by adjusting the observed K and L hyperfine spectra of the experi-

mentally determined quadrupole moments $Q_0$ support the general idea of the rotation-vibration model. (auth)

**46835** ISOMER SHIFT AND AFTEREFFECT. Kankeleit, E.; Koerding, A. (Technische Hochschule, Darmstadt, Ger.). pp 92-4 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The frequency spectrum of a $\gamma$ ray has been calculated for the following situation. An excited nuclear state is produced by a preceding transition. This transition also excites an electronic state by, for instance, the nuclear charge change in $\beta$ decay, conversion and Auger processes, or recoil effects. In this excited electronic state, the isomer shift (arguments as follow apply also to other hyperfine interactions) may be different than for the ground electronic state. The situation is more complicated if the two lines are only slightly separated. Now interference causes a positive structure between the lines and negative contributions at the outer end of the two lines. Of course, the sum of the contributions in the emission spectrum is everywhere positive. This effect might have some bearing on an experimental observation by Steichele et al. In a Moessbauer spectrum taken with the 97-keV $\gamma$ ray of a $^{153}Gd_2O_3$ source and an $^{153}Eu_2O_3$ absorber, an asymmetry was found which was attributed to an aftereffect due to the electron capture decay of $^{153}Gd$. A new measurement of this Moessbauer spectrum is shown. The dashed curve is a mirror image of a curve fitted to the negative-velocity data. The asymmetry is clearly visible. A set of calculated Moessbauer spectra is presented with different sets of parameters. These curves illustrate that an explanation in terms of the above theory may be possible. (auth)

**46836** ANTILINEAR OPERATORS IN HARTREE-BOGOLYUBOV THEORY. I. Herbut, Fedor (Inst. of Nuclear Sciences Boris Kidrich, Belgrade); Vujicic, Milan. Phys. Rev., 172: 1031-46(Aug. 20, 1968).

The Hartree–Bogolyubov (HB) theory is formulated in a basis-independent way, i.e., in terms of linear and antilinear operators acting in the one-particle space. For that purpose, some basic antilinear algebra is presented. The pairing tensor and the pairing potential are shown to represent two antilinear skew-Hermitian operators. The polar factorization of the first of them (the correlation operator $\hat{t}_a$), i.e., $\hat{t}_a = (\hat{\rho} - \hat{\rho}^2)^{1/2}\hat{P}_a$, shows that HB theory has only two variational (trial) operators: the density operator $\hat{\rho}$ and the antilinear pairing operator $\hat{P}_a$ which is defined by the properties $\hat{P}_a^\dagger = \hat{P}_a^{-1} = -\hat{P}_a$. These two operators commute. The former is the unique and very well-known variational operator of Hartree-Fock (HF) theory, and the latter represents a new variational freedom typical of HB theory. Most calculations, as for instance the Bardeen–Cooper–Schrieffer (BCS) approximation, restrict this freedom by choosing $\hat{P}_a$ to be the time-reversal operator. The basic dynamical (Euler–Lagrange) equations of HB theory are obtained directly by varying linear and antilinear operators. They are expressed in a compact form, using only commutators and anticommutators of the kinematical and the dynamical operators: $\hat{A}_a \equiv [\hat{h},\hat{t}_a]_+ - [\hat{\Delta}_a,\hat{\rho} - \frac{1}{2}]_+ = 0$, $\hat{B} \equiv [\hat{h},\hat{\rho}]_- - [\hat{\Delta}_a,\hat{t}_a]_- = 0$, where $\Delta_a$ is the pairing potential and $\hat{h}$ is the one-particle Hamiltonian. Two identities are found between $\hat{A}_a$ and $\hat{B}$ which turn out to be very useful for obtaining solutions. Symmetries of the trial operators and of the solutions are discussed in great detail, special attention being paid to real HB solutions and their connection with some antiunitary symmetries. Several simple solutions are analyzed: the case where $\hat{\rho}$ is restricted to be a projector, i.e., $\hat{t}_a = 0$ (HF case); the case where $\hat{\rho}$ and $\hat{P}_a$ are restricted to commute with a complete set of observables, which determines the eigensubspaces of $\hat{\rho}$, and which, in particular cases of rotational and translational symmetries, fixes $\hat{P}_a$ to be equal to the time-reversal operator (BCS case); and the case where $\hat{P}_a$ is any given symmetry operator of the Hamiltonian. (auth)

**46837** ANGULAR CORRELATIONS AND SYMMETRY TESTS. Boehm, F. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. pp 279-94 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The fundamental transformation properties in the space and the time coordinates referred to as parity and time-reversal symmetries can be studied with the help of directional correlation experiments of nuclear radiation. Tests of the parity symmetry, the time-reversal symmetry which preserves parity, and the time-reversal symmetry which does not preserve parity are possible in nuclear physics, each requiring one or several specific combinations of vectors describing momentum, spin, and polarization. While it has been long known and well understood in terms of the basic property of weak interaction that a maximum amount of parity-non-conservation is present in nuclear beta decay, only a very small amount of parity-non-conservation of the order of 1 part in $10^4$ in amplitude is found in nuclear forces from a correlation experiment. This is roughly the amount predicted by the current-current theory of weak interaction. To the present, no evidence for a time-reversal asymmetry has been detected in nuclear physics both in pure weak interaction (beta decay) and in nuclear forces. However, the limits are not better than about 1 part in $10^2$ in amplitude. (auth)

**46838** DYNAMIC ORIENTATION OF NUCLEI. Jeffries, C. D. (Univ. of California, Berkeley). Contract AT(11-1)-34. pp 775-88 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968. (UCB-34-P-20-OR-4).

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

A review is given of the various methods in which nuclei may be preferentially oriented by pumping a reasonance of the system in the microwave or optical regions. Some microwave cases discussed are: the Overhauser effect in metals; contact and dipolar interaction in paramagnetic crystals; and liquids. Nuclear polarization in gases and solids by optical pumping is briefly discussed. A discussion is given of nuclear spin refrigerators, in which nuclear orientation is achieved by crystal rotation rather than by pumping. The relative advantages of the various methods are pointed out. (auth)

**46839** IMPLANTATION OF EXCITED NUCLEI INTO FERROMAGNETIC HOSTS. Grodzins, L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 607-39 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

A review dealing with internal fields acting on nuclei implanted into various solid hosts is presented. The technique of implanting excited nuclei, using the recoil from reactions, radioactive decay, or Coulomb excitation, is referred to by the acronym IMPACT. IMPACT studies of internal fields are carried out immediately, necessitating the understanding of transient phenomena, as well as quasistatic effects such as radiation damage. A discussion of the phenomena encountered with this technique is a primary focus of this talk. IMPACT measurements are compared with corresponding results obtained by using radioactive sources doped into iron, either metallurgically or by means of an isotope separator. A simple phenomenological model, which assumes that $H_1$ acts for a short time, $\tau_1$, is used to correct IMPACT data. The resulting g-factors, especially for longer-lived states, are quite insensitive to the choices of the parameters. It appears that g-factors of first $2^+$ states of vibrational nuclei are reasonably nuclei. (auth)

**46840** INTERNAL FIELDS AND IMPLANTATION TECHNIQUES. Goldring, G. (Weizmann Inst. of Science, Rehovoth, Israel). pp 640-54 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

A number of experiments are summarized in which nuclear moments and the structure of internal atomic fields were investigated using implantation of excited nuclei in various materials. Recoil into solids, liquids, vacuum, and gases is discussed. (D.C.W.)

**46841** POSSIBLE APPLICATIONS OF PERTURBED ANGULAR DISTRIBUTIONS IN HIGH INTERNAL MAGNETIC FIELDS. Klepper, O.; Lehmann, L.; Spehl, H. (Univ., Freiburg i. B.). pp 767-72 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Three possible applications are described which make use of the high internal magnetic fields in a ferromagnetic lattice: a method to measure ranges of very heavy ions; a method to observe the rapid time dependence of hfs interaction during free flight in vacuum; and a method for lifetime measurements in the 10-psec region. (auth)

**46842** SELECTION RULES FOR INTERFERENCE IN PERTURBED ANGULAR CORRELATIONS. Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 379-83 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.).

Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The theory of perturbed angular correlations is reformulated for the case of time-independent interactions. The correlation functions obtained display explicitly the interference properties of individual energy levels of the intermediate state. It follows that a time-differential correlation experiment provides a direct measure of the energy splittings of interfering states, irrespective of the interaction K between nucleus and environment. Furthermore, the same interference may lead to the observation of resonances in a time-integrated correlation experiment. However, not all pairs of eigenstates are capable of interference. Selection rules for interference that follow from general symmetry properties of the Hamiltonian K are obtained. A number of rules that appropriate to problems having axially symmetric interactions K are derived. Based on time-reversal invariance of K, general rules concerning interference of time-reversed states are also given. (auth)

**46843** ZERO-FIELD RESONANCE IN ANGULAR CORRELATIONS PERTURBED BY AN ISOTROPIC HYPERFINE INTERACTION. Leisi, H. J. (Franklin Inst., Swarthmore, Pa.). pp 384-9 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The resonance that can be observed in a time-integrated angular correlation experiment in the vicinity of zero external magnetic field has been calculated for an arbitrary hyperfine interaction of a monoatomic gaseous source. Explicit results are obtained for $\gamma$-$\gamma$ directional correlations by assuming time-independent interaction. Quantities that can be determined from such experiments are discussed. (auth)

**46844** ZERO-FIELD RESONANCE IN ANGULAR CORRELATION WITH A PARAMAGNETIC POWDER SOURCE. Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 390-6 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The zero-field resonance that is predicted to occur in an angular correlation experiment using a paramagnetic single crystal source is shown to exist also with a powder source. The line shape of the resonance is calculated for a strictly axially symmetric hyperfine interaction appropriate to a Kramers doublet state. The resonance is shown to exist only if the nuclear spin I is half-integral. The expected resonance height is calculated for $I = 3/2$, $5/2$, and $7/2$ as a function of the magnetic anisotropy of the interaction. Effects of deviations from an axially symmetric hyperfine interaction are indicated. (auth)

**46845** RESONANCES IN PERTURBED ANGULAR CORRELATIONS DUE TO REPELLING LEVELS. Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 397-403 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

Two energy levels of the intermediate state that cross as a function of an applied magnetic field give rise to a resonance in a time-integrated angular correlation experiment, provided the corresponding two states interfere. It is shown that there exists a mechanism that may produce a resonance even if the two states do not interfere according to the dominant part of the Hamiltonian. Very small additional terms may give rise to a mixing of the two states and a repulsion of the corresponding energy levels. If the resulting energy splitting at crossing is not much smaller than the natural width of the intermediate state, a large resonance in the angular correlation results. Apart from providing an additional mechanism for resonances, the effect may also prove useful for measuring small terms of the interaction Hamiltonian. The phenomenon is illustrated in the case of a paramagnetic ion with a hyperfine interaction of the form $AI_zJ_z$. The mixing of states due to small terms in the Hamiltonian may also modify resonance line shapes of interfering states. (auth)

**46846** SYMMETRY TESTS WITH THE MOESSBAUER EFFECT. Kistner, O. C. (Brookhaven National Lab., Upton, N. Y.). pp 295-313 of Hyperfine Structure and Nuclear Radiations. Matthias, E.; Shirley, D. A. (eds.). Amsterdam, North-Holland Publishing Co., 1968.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif. See UCRL-17800; CONF-670812.

The Moessbauer effect has valuable applications in testing the conservation of the various symmetries in the nuclear $\gamma$-decay interaction. Recently Bernstein, Feinberg, and Lee have pointed out the need for a sensitive test of time-reversal invariance in nuclear $\gamma$ decay in order to test T invariance of the electromagnetic interaction of the strongly interacting particles. The experiments performed to test parity conservation in the 14-keV transition in $^{57}Fe$ are reviewed. A recently performed Moessbauer experiment is then described which tests time-reversal invariance in the 90-keV mixed transition in $^{99}Ru$. The fraction of T-noninvariant amplitude over the total amplitude of the $\gamma$-decay matrix element is equal to the sine of the phase angle $\phi$ between the two multipole amplitudes of a mixed transition. This experiment employs linearly polarized radiation to measure a term of the form $(\vec{k}\cdot\vec{\epsilon}\times\vec{J})(\vec{k}\cdot\vec{J})(\vec{\epsilon}\cdot\vec{J})$, which is directly proportional to $\sin\phi$. No evidence for T noninvariance was found; the result is $\sin\phi = 1.0 \pm 1.7 \times 10^{-3}$. (auth)

**46847** CORRECTION OF MOMENT METHOD FOR FINITE RANGE OF INTEGRATION AND ITS APPLICATION TO LIFE-TIME ANALYSIS. Morales, R.; Millett, W. E. (Univ. of Texas, Austin). Nucl. Instrum. Methods, 64: 13-20(Sept. 1, 1968).

A correction of the moment method for finite range of integration has been introduced and has been applied in detail to the particular case of lifetime data analysis. In the case in which one or two mean lives occur, the method has been shown to work for a wide range of mean lives and fractions of the long component. In addition, techniques are proposed which minimize the troublesome problem of centroid shift by an indirect determination of the best centroid. (auth)

**46848** DOORWAY STATE THEORY OF NEUTRON-NUCLEAR REACTIONS. Takeuchi, Kenji. Ann Arbor, Mich., Univ. of Michigan, 1967. 246p.

Thesis.

The doorway state theory for neutron-nuclear reactions in the energy region below 10 MeV is extended. The importance of the doorway state arises from the fact that the deviation of the optical model calculations may be explained in terms of the doorway state, and that it is one of the internal degrees of freedom of the compound nucleus. The historical and theoretical preliminaries together with the basic notations for all the parts of this thesis are provided. The effects of the doorway states on the complex potential are determined with a resulting generalization of the optical model. The fine structure of doorway states is developed for determination of the dynamical constants of the doorway state, for shape study of the cross sections, and for discussion of the bumps in the cross sections in the continuum energy region. A shell model calculation of the doorway state formation probabilities of $^{58}Ni$ is presented. The values of $\Gamma\uparrow$ obtained agree well with the values analyzed from the experimental data. In addition a large bump in the total cross section around 1 to 2 MeV is predicted. The general success of the several applications tends to support the doorway state Ansatz. (Disser. Abstr.)

**46849** NEW STRIPPING ANALYSIS. Rodberg, Leonard S. (Univ. of Maryland, College Park). Ann. Phys. (N. Y.), 48: 254-7(June 2, 1968).

A new approach to stripping theory was proposed by Butler, Hewitt, McKellar, and May (Ann. Phys., 43: 282(1967)) in which inherent approximations in DWBA theory were avoided. It is shown that this approach is in error and that the method leads to the same point as other formulations of stripping theory. (J.W.R.)

**46850** ON THE BHMM STRIPPING ANALYSIS. Butler, S. T. (Univ. of Sydney). Ann. Phys. (N. Y.), 48: 258-64 (June 2, 1968).

The BHMM approach for (d,p) analysis is briefly presented in a form convenient for comparison with the preceding comments by Leonard S. Rodberg. The conclusion by Rodberg that the BHMM approach is invalid is shown not to be correct. (auth)

**46851** NEAREST-NEIGHBOR SPACING DISTRIBUTION FOR AN ENSEMBLE OF RANDOM MATRICES WITH A NONRANDOM BIAS. McDonald, J. F.; Favro, L. D. (Wayne State Univ., Detroit). J. Math. Phys. (N. Y.), 9: 1114-19(July 1968).

The nearest-neighbor spacing distribution for the biased Gaussian distribution $\exp[-\gamma\,\mathrm{Tr}(H - H_0)^2]$ is calculated in the limits of large and small $\gamma$. The results for the small $\gamma$ limit are found to approach those for an unbiased Gaussian distribution (i.e., $H_0$ proportional to the unit matrix). To order $\gamma^2$ the mth-order spacing distribution is expressed in terms of the mth-order spacing distribution for the unbiased Gaussian ensemble. The results for the large-$\gamma$ limit are found to depend strongly on $H_0$. That is, the nearest-neighbor spacing distribution reflects the structure of $H_0$. Thus, a biased distribution offers a possible description of the experimental deviations from the Wigner surmise and apparent multiple-peak structure exhibited by some nuclear-spacing data. (auth)

**46852** REACTION MATRICES FOR FINITE NUCLEI. Grillot, David V. East Lansing, Mich., Michigan State Univ., 1967. 98p.

Thesis.

A method for calculating the reaction matrix elements of a closed-shell nucleus is discussed. An improved treatment of the Pauli operator is proposed, and accurate solutions of the Bethe–Goldstone are obtained for the coupled and uncoupled integro-differential equations. The solutions are used to obtain the first-order binding energy of $^{16}O$ using the Hamada–Johnston and Brueckner–Gammel–Thaler potentials. The results indicate that the Hamada–Johnston potential gives too little binding, and possible ways of improving the binding energy calculations are discussed. The reaction matrix is examined as a function of the single particle energies. It was found that the $^3S_1$ states are very sensitive to the choice of single-particle energies; whereas, the $^1S_0$ states are relatively insensitive to this choice. Calculated singularities of the reaction matrix are also reported for both the $^1S_0$ and $^3S_1$ states. (Disser. Abstr.)

**46853** RESONANCE ABSORPTION AND RESONANCE FLUORESCENCE OF ATOMIC NUCLEI. Ziegler, B. (Max-Planck-Instituts fuer Chemie, Mainz). Naturwissenschaften, 55: 261-5 (June 1968). (In German).

Three classical atomic physics experiments for the study of resonance absorption and resonance fluorescence are outlined. These are electron scattering, $\gamma$ absorption, and $\gamma$ scattering. Typical measurements from each type of experiment are discussed, and the theoretical implications are considered. (J.S.R.)

**46854** PARITY-VIOLATING NUCLEAR FORCES. Waeffler, Hermann (Max-Planck-Instituts fuer Chemie, Mainz). Naturwissenschaften, 55: 255-61(June 1968). (In German).

Beta decay is discussed using the very simple and extensively studied example of the positron emitter $^{14}O$. The analysis of the decay shows the existence of a hypothetical weak nuclear force. Experiments for the detection of this parity-violating force are proposed. These are based on neutron capture in cadmium, measurement of circularly polarized $\gamma$ radiation, and some nuclear processes. (J.S.R.)

**46855** SMALL ANGLES OF ANTIPROTON–COMPLEX NUCLEI ELASTIC SCATTERING IN NUCLEAR EMULSION AT 3 GeV/c. Bermond, Jacques; Brou, Rene; Flard, Michel; Le Querler, Yves (Faculte des Sciences, Caen, France). J. Phys. (Paris), 29: 395-401(May-June 1968). (In French).

Nuclear optical model parameters (interaction radius $R = R_0A^{1/3}$; real $V_0$ and imaginary W potential parts) are estimated from experimental elastic scattering spectra of antiprotons at 3 GeV/c on complex nuclei in photographic emulsion. Scanning and calculation of angles are made by two different ways, one of which is especially designed for semiautomatic detection of angles less than 9 MRd. The best fit gives the following results: $R_0 = 1.37 \pm 0.10$ fermi; $V_0 = 23 \pm 8$ MeV; $W = 32 \pm 10$ MeV for an angular region which projects on a 3 to 39 MRd interval. (auth)

# REACTOR TECHNOLOGY

## Central Power Reactors

*Refer also to abstracts 45220, 45266, 45757, 45763, 45822, and 45833.*

**46856** (AI-AEC-12696) PIQUA NUCLEAR POWER FACILITY SURVEILLANCE AND RECOVERY PROGRAM. Final Report. Eggleston, R. R. (ed.) (Atomics International, Canoga Park, Calif.). June 15, 1968. Contract AT(04-3)-701. 54p. Dep. CFSTI.

A plant description and brief operation history are presented. Core and coolant cleanup and system modifications are described. Control rod modifications are also described. Coolant tests for oxidation and thermal decomposition are discussed. Surveillance program results are presented. Program termination status is described. (D.C.C.)

**46857** (AI-CE-77) HEAVY WATER ORGANIC COOLED REACTOR. COMPATIBILITY OF HYPERSTOICHIOMETRIC UC AND SINTERED ALUMINUM POWDER (SAP). Bremer, A. B. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. [Nuclear Div.]). May 31, 1968. Contract AT(38-1)-430. 64p. Dep. CFSTI.

The status of hyperstoichiometric UC fuel–SAP cladding compatibility studies, applicable to HWOCR conditions, is presented. Diffusion couple interfaces were evaluated, both metallurgically and statistically. Regression equations established correlations between test conditions and the dependent variables of "total reaction thickness" and "uniform reaction thickness." An incubation period, which occurs early in the compatibility reaction, is described. A U–Al–Si phase and impurity elements, including Si and Fe, were detected in the reaction zone by electron beam microprobe analysis. $UAl_3$ and C (graphite) were detected by X-ray diffraction. A comparison of in-pile and out-of-pile compatibility data suggests an absence of irradiation effects. The influence of diffusion couple interfacial pressure on the compatibility reaction is discussed. Six steps are suggested to define the compatibility reaction process. 24 references. (auth)

**46858** (ANL-7424) POSTFABRICATION EVALUATION OF INTEGRITY AND SERVICEABILITY OF CANNED GRAPHITE FOR THE EBR-II NEUTRON SHIELD. Heineman, A. H. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

The neutron shield for EBR-II consists of plain and/or boronated graphites in Type 304 stainless steel cans positioned inside and around the reactor vessel and within the vessel cover. A series of pre- and post-fabrication tests of the reliability and integrity of the neutron shield in EBR-II operating conditions, exclusive of radiation, are described. The tests include: prefabrication tests of prototype can assemblies and graphite to develop commercial fabrication criteria, postfabrication tests of spare as-built cans to ensure vendor conformity with specifications, and tests with deliberately defected cans to assess the consequences of deviations from specifications or can failure on reactor safety and operation. The tests indicate that can performance and fabrication procedures are satisfactory. (H.D.R.)

**46859** (ANL-7434) REVIEW OF LOW-MASS ATOM PRODUCTION IN FAST REACTORS. Dudey, Norman D. (Argonne National Lab., Ill.). Apr. 1968. Contract W-31-109-eng-38. 37p. Dep. CFSTI.

A literature review of low-mass charged-particle yields in fission is presented. A semiempirical method for calculating the yields of H and He isotopes from fast-neutron fission of U and Pu is presented. Total and specific production rates of $^{1}H$, $^{2}H$, $^{3}H$, $^{3}He$, $^{4}He$, and $^{6}He$ are estimated for the reactor fuels $^{233}U$, $^{235}U$, and $^{239}Pu$. The T production in reactor fuels is estimated at 327 Ci per metric ton of $^{235}U$ fuel and 440 Ci per metric ton of a 50% mixed $^{235}U-^{239}Pu$ thermal reactor fuel having a burnup rating of 20,000 MW(t)-D. T production in fast reactors is estimated to be 10% lower for $^{235}U$ fuel and 10% higher for $^{239}Pu$ fuel than for thermal reactors. An examination of all sources of H and He in EBR-II is presented. Neutron reactions of stainless steel are shown to produce 90% of the $H_2$ and 10% of all He-produced in EBR-II. T production in fast reactors is shown to result almost entirely from fission. A Pu-fueled fast reactor is estimated to produce nearly twice as much T as a U-fuel thermal reactor. 77 references. (auth)

**46860** (APDA-CFE-21) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, APRIL 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). July 1968. Contract AT(11-1)-865. 46p. Dep. CFSTI.

Development of the chiseling and arc melting concepts for screw head removal to free the remaining zirconium segments from the conical flow guide in the inlet plenum of the reactor core was continued. A full-length chisel tool is being fabricated for testing in an improved mockup of the reactor inlet plenum. An approach being investigated for removing the zirconium segments is to withdraw them through the 14-inch inlet line with a strengthened object-retrieval gripper. An extensive viewing and photographing program disclosed no other foreign objects inside the reactor vessel. Experimental work reasonably confirmed that the zirconium object previously removed could have caused the melting of fuel in subassemblies M127 and M098. The bellows failures in two valves in the primary sodium service system were found to be localized intergranular attack at the inside surface of the bellows. (H.D.R.)

**46861** (BNWL-770) CLOTHO: A CODE FOR COMMUNICATING REACTOR MASS BALANCE DATA TO REACTOR ECONOMICS CODES. Nail, J. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1968. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

The CLOTHO code was designed to convert data from burnup codes to a form convenient for analysis by economics codes. CLOTHO uses material balances (burnup) punched on cards from sources other than the ALTHAEA burnup code and converts these cards to a pseudo-ALTHAEA burnup tape. ALTHAEA communicates via magnetic tape with the QUICK code for analysis of fuel cycle costs and the PACTOLUS code for analysis of total power costs. CLOTHO is designed to change the load history, parameterize reactor characteristics, and, by appropriate choice of input data, to simulate fossil-fueled electrical generating plants. (H.D.R.)

**46862** (DLCS-5000268) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], SECOND QUARTER, 1968. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 24p. Dep. CFSTI.

Operations during April to June 1968 are described. Topics discussed include: water chemistry, refueling, maintenance, and test program. (D.C.C.)

**46863** (DOCKET-50219-15) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 37. (Jersey Central Power and Light Co., Morristown, N. J.). Apr. 15, 1968. 158p. Dep. CFSTI.

Information is given concerning the reactor vessel repair program for Oyster Creek Power Reactor, Unit 1. The safety evaluation of the difficulties and the proposed repair program includes: control rod drive and flux monitor tube penetrations, nozzles, shroud support ring, and reactor vessel internals. An analysis of causes of known defects is given; the metallurgical sampling and test program is outlined. Stub tube stress analyses are described; data are tabulated. Possible methods for stub tube repair are listed. Compliance with applicable AEC General Design Criteria is considered. The nature and significance of all fabrication defects which have been detected in the reactor coolant system are discussed. The suitability of 308L weld clad stub tubes is analyzed. The Combustion Engineering report number CENC-1109, "Feasibility Study Report on Removing and Replacing CRD [control rod drive] Stub Tubes from Jersey Central P and L Co. BWR at Oyster Creek, New Jersey Site" is included. (M.L.S.)

**46864** (DOCKET-50237-2) DRESDEN NUCLEAR POWER STATION, UNIT 2, COMMONWEALTH EDISON COMPANY. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). Nov. 24, 1965. 3p. Dep. CFSTI.

The ACRS report on Dresden Power Reactor, Unit 2 is presented in full. (M.L.S.)

**46865** (DOCKET-50237-3) APPLICATION FOR CONSTRUCTION PERMIT AND OPERATING LICENSE FOR DRESDEN, UNIT 2. [Amendment Reflecting Addition of Unit 3]. [Plant Description and Analysis Report]. (Commonwealth Edison Co., Chicago, Ill.). Mar. 30, 1966. 69p. Dep. CFSTI.

Areas of overlap between the Dresden Power Reactor, Units 2 and 3 are outlined. Changes are listed for the following systems: interconnections and sharing of auxiliary systems and common

facilities; turbine generator requirements; reactor vessel overall length; fuel rod pitch; recirculating loops design pressures; primary system hydrostatic testing; primary containment system; standby diesel generator; circulating water system and feedwater heaters; isolation condenser system; and refinements in some accident analyses. (M.L.S.)

**46866** (DOCKET-50237-4) DRESDEN NUCLEAR POWER STATION, UNIT 2. VOLUME I. PLANT DESIGN AND ANALYSIS REPORT. (Commonwealth Edison Co., Chicago, Ill.). Apr. 15, 1965. 22p. Dep. CFSTI.

A summary description of Dresden Power Reactor, Unit 2 is given. (M.L.S.)

**46867** (DOCKET-50237-5) DRESDEN NUCLEAR POWER STATION, UNIT 2. Plant Design and Analysis Report, Amendment 1. (Commonwealth Edison Co., Chicago, Ill.). July 12, 1965. 71p. Dep. CFSTI.

Design features of Dresden Power Reactor, Unit 2 are listed; these are compared with Oyster Creek and Nine Mile Point. Revised information is given on: core nuclear characteristics, instrumentation and control systems, accident analyses, and climatological data. (M.L.S.)

**46868** (DOCKET-50237-6) DRESDEN NUCLEAR POWER STATION, UNIT 2. Plant Design and Analysis Report, Amendment 2. (Commonwealth Edison Co., Chicago, Ill.). Aug. 17, 1965. 126p. Dep. CFSTI.

Plant design characteristics of Dresden Power Reactor, Unit 2 are summarized. Characteristics are described for: fuel and control rods, plant and reactor stability, jet pumps, containment systems, reactor protection systems, standby liquid control system, fission product release during routine operation, seismic design of Class I and Class II structures, electrical power supply, and reactor instrumentation. Analyses of hypothetical accidents and their consequences are included. (M.L.S.)

**46869** (DOCKET-50237-7) DRESDEN NUCLEAR POWER STATION, UNIT 2. Plant Design and Analysis Report, Amendment 4. (Commonwealth Edison Co., Chicago, Ill.). Sept. 16, 1965. 54p. Dep. CFSTI.

Jet pump performance is analysed with respect to stability of the Dresden Power Reactor, Unit 2. Turbine trip accidents and turbine response are evaluated. The design and design philosophy of the dual channel safety system is discussed. Total reactivity coefficients are shown as a function of temperature, power, and core lifetime. The analysis of the steam line break accident, based on Dresden Unit 1 data, is discussed. (M.L.S.)

**46870** (DOCKET-50237-8) DRESDEN NUCLEAR POWER STATION, UNIT 2. Plant Design and Analysis Report, Amendment 5. (Commonwealth Edison Co., Chicago, Ill.). Oct. 21, 1965. 24p. Dep. CFSTI.

Additional information on Dresden Power Reactor, Unit 2 is given on the following subjects: reactor stability analyses of operation with multiple jet pumps, metal-water reaction analyses, missile penetration of the containment vessel, Doppler coefficient calculations, local void coefficient determination, and valve redundance to assure containment for any steam line failure. (M.L.S.)

**46871** (DOCKET-50249-2) DRESDEN NUCLEAR POWER STATION, UNIT 3. VOLUME I. PLANT DESIGN AND ANALYSIS REPORT. (Commonwealth Edison Co., Chicago, Ill.). Feb. 14, 1966. 315p. Dep. CFSTI.

In addition to the license application for Dresden Power Reactor, Unit 3, information is given on the following broad topics: Introduction and Summary; Principal Architectural and Engineering Criteria for Design; Identification of Major Features or Components Respecting which Further Information is Required; Reactor Design; Plant Safeguards Features; Radioactive Waste Control Systems; Plant Electrical System; Process, Area, and Health Monitoring; Other Plant Features; General Plant Control and Instrumentation; Safety and Accident Analysis; and Plant Management. (M.L.S.)

**46872** (DOCKET-50249-4) DRESDEN NUCLEAR POWER STATION, UNIT 3, COMMONWEALTH EDISON COMPANY. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). Aug. 16, 1966. 4p. Dep. CFSTI.

The complete ACRS report on Dresden Power Reactor, Unit 3 is presented. (M.L.S.)

**46873** (DOCKET-50249-5) DRESDEN NUCLEAR POWER STATION, UNIT 3. Plant Design and Analysis Report, Amendment 1. (Commonwealth Edison Co., Chicago, Ill.). May 4, 1966. 89p. Dep. CFSTI.

The nil ductility transition temperature (NDTT) for Dresden Power Reactor, Unit 3 pressure vessel is discussed; effects of integrated neutron dose (nvt) are shown graphically. The sharing of systems between Units 2 and 3 is discussed. Detailed information is given relative to the reactor pressure vessel. Various aspects of station design are considered; engineered safeguards are described. Design basis accident effects on containment are described. A complete excursion analysis for a hypothetical fuel loading accident is given. (M.L.S.)

**46874** (DOCKET-50249-6) DRESDEN NUCLEAR POWER STATION, UNIT 3. Plant Design and Analysis Report, Amendment 2. (Commonwealth Edison Co., Chicago, Ill.). May 17, 1966. 18p. Dep. CFSTI.

Effects of erroneous withdrawal of control rods are discussed; containment vessel integrity is considered. The design of the shared containment spray system is evaluated. Separability of emergency and standby power systems is discussed briefly. (M.L.S.)

**46875** (DOCKET-50249-7) [DRESDEN NUCLEAR POWER STATION, UNIT 3]. [Plant Design and Analysis Report], Amendment 3-1. (Commonwealth Edison Co., Chicago, Ill.). May 26, 1966. 5p. Dep. CFSTI.

Revised information on coolant loss accidents, and drywell and core spray cooling systems for the Dresden Power Reactor, Unit 3 is given. (M.L.S.)

**46876** (DOCKET-50249-8) DRESDEN NUCLEAR POWER STATION, UNIT 3. Plant Design and Analysis Report, Amendment 3-2, Summary Memorandum on Excursion Analysis Uncertainties. Boyden, J. E.; Brammer, H. A.; Wood, J. E. (General Electric Co., [San Jose, Calif.] Atomic Power Equipment Dept.). May 23, 1966. 38p. Dep. CFSTI.

For Commonwealth Edison Co., Chicago, Ill.

Effects of uncertainties on reactivity excursion analyses for Dresden Power Reactor, Unit 3 are detailed. The calculational model is described; statistical and probabilistic (state of reactor) uncertainties associated with calculations are analysed. Secondary reactivity effects are evaluated. Fuel failure mechanisms and damage thresholds are determined. 17 references. (M.L.S.)

**46877** (DOCKET-50249-9) [DRESDEN NUCLEAR POWER STATION, UNIT 3]. Plant Design and Analysis Report, Amendment 4. (Commonwealth Edison Co., Chicago, Ill.). July 8, 1966. 44p. Dep. CFSTI.

A financial statement for Commonwealth Edison is given in support of a license application for Dresden Power Reactor, Unit 3. Included is the 1965 Annual Report. (M.L.S.)

**46878** (DOCKET-50249-10) [DRESDEN NUCLEAR POWER STATION, UNIT 3]. Plant Design and Analysis Report, Amendment 5. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 22, 1968. 201p. Dep. CFSTI.

For Commonwealth Edison Co., Chicago, Ill.

A detailed analysis of the Emergency Core Cooling System (ECCS) for Dresden Power Reactor, Unit 3 is given. Design bases for the ECCS are outlined; the design of the two-core spray system is analysed; schematics are given. The model used to predict core spray system availability is described; structural integrity of essential core components is evaluated. Calculation of core response to emergency cooling is described; break spectrum analyses are given. Core spray margins are determined. The reactor internal pressure difference model is given; the core spray test program is described. Heat transfer during blowdown is calculated; the core heatup analysis model is given. The high pressure coolant injection system is detailed. The reactor coolant inventory model is described. Performance of the integrated ECCS is evaluated. (M.L.S.)

**46879** (DOCKET-50254-1) QUAD-CITIES STATION, UNITS 1 AND 2. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). Dec. 14, 1966. 3p. (DOCKET-50265-1). Dep. CFSTI.

The complete ACRS report on Quad Cities Power Reactor, Units 1 and 2 is included. (M.L.S.)

**46880** (DOCKET-50254-2) [QUAD-CITIES STATION, UNITS 1 AND 2]. [Plant Design Analysis], Amendment 2. (Commonwealth Edison Co., Chicago, Ill.). Sept. 9, 1966. 144p. (DOCKET-50265-2). Dep. CFSTI.

The precautions taken to minimize radioactivity release from Quad Cities Power Reactor, Units 1 and 2 are described. Effects of turbine-generator failure are analyzed. Tornado design criteria are detailed; maximum earthquake ground acceleration values are given. Quality control procedures for containment structures are outlined. Detailed information is given for the containment system.

The design of the rod-block system is analyzed. Detailed information is given on the reactor core isolation cooling system. Design specifications, vessel classifications for fabrication, lifetime design cycles for each transient, and requirements imposed over and above code rules are included for the primary system. The core cooling systems and effects of their operation are considered. (M.L.S.)

**46881** (DOCKET-50254–3) [QUAD-CITIES STATION, UNITS 1 AND 2]. [Plant Design Analysis], Amendment 3, Pt. 1. (Commonwealth Edison Co., Chicago, Ill.). Oct. 18, 1966. 47p. (DOCKET-502565–3). Dep. CFSTI.

The financial qualifications of the Commonwealth Edison Company, owners of Quad Cities Power Reactor, Units 1 and 2, are given. Also included is the 1965 Annual Report of the company. (M.L.S.)

**46882** (DOCKET-50254–4) QUAD-CITIES STATION, UNITS 1 AND 2. [Plant Design Analysis], Amendment 3, Pt. 2. (Commonwealth Edison Co., Chicago, Ill.). Oct. 18, 1966. 127p. (DOCKET-50265–4). Dep. CFSTI.

Information on Quad Cities Power Reactor, Units 1 and 2, is given on the following subjects: shared systems, bases for liquid waste release, turbine rotor failure, tornadoes, dispersal of radioactivity in the Mississippi River, water storage capacity and usage rate, 1,000 year flood level, isolation valve tests, secondary containment design, compliance with AEC Design Criteria Nos. 17 and 18, containment spray header design criteria, engineered safeguards, jet pump tests and behavior, primary system, water source for engineered safeguards, refueling accident analysis, and water spillage damage effects. (M.L.S.)

**46883** (DOCKET-50254–5) QUAD-CITIES STATION, UNITS 1 AND 2. [Plant Design Analysis], Amendment 4. (Commonwealth Edison Co., Chicago, Ill.). Nov. 25, 1966. 97p. (DOCKET-50265–5). Dep. CFSTI.

Design details of the Emergency Core Cooling Systems for Quad Cities Power Reactor, Units 1 and 2 are given; this includes the core spray systems, high pressure coolant injection system, low pressure coolant injection, automatic pressure relief of primary system, standby coolant supply system, and drywell arrangements. Design drawings are included. (M.L.S.)

**46884** (DOCKET-50254–6) [QUAD-CITIES STATION, UNIT 1]. [Plant Design Analysis], Amendment 1. (Commonwealth Edison Co., Chicago, Ill.). Aug. 18, 1966. 120p. (DOCKET-50265–6). Dep. CFSTI.

The request from Commonwealth Edison to the AEC for license to add a second unit to the Quad Cities Station is included. Revisions are given which reflect changes necessary for adding the Unit 2. (M.L.S.)

**46885** (DOCKET-50254–7) APPLICATION FOR CONSTRUCTION PERMIT AND OPERATING LICENSE FOR QUAD-CITIES, UNIT 1. (Commonwealth Edison Co., Chicago, Ill.). May 31, 1966. 7p. Dep. CFSTI.

The license application for Quad Cities Power Reactor, Unit 1 contains: a list of the directors for Commonwealth Edison Company; a list of uranium and plutonium balances; and a schedule of transfers of Special Nuclear Materials through 2008. (M.L.S.)

**46886** (DOCKET-50254–8) QUAD-CITIES STATION, UNIT 1. VOLUME I. PLANT DESIGN ANALYSIS. (Commonwealth Edison Co., Chicago, Ill.). June 1, 1966. 374p. Dep. CFSTI.

Information on Quad Cities Power Reactor, Unit 1 is given under the following broad topics: Introduction and Summary; Site and Environs; Reactor Design; Reactor Coolant System; Containment Systems; Additional Engineered Safeguards Features; Radioactive Waste Control Systems; Station Electrical Systems; Station Control and Instrumentation; Reactor Auxiliary Services and Systems; Power Conversion System; Other Station Structures; Conduct of Operations; and Safety Analysis. (M.L.S.)

**46887** (DOCKET-50254–9) QUAD-CITIES STATION, UNIT 1. VOLUME II. PLANT DESIGN ANALYSIS. (Commonwealth Edison Co., Chicago, Ill.). June 1, 1966. 242p. Dep. CFSTI.

The engineering drawings for Quad Cities Power Reactor, Unit 1 are presented. Also included are: reliability analysis of the reactor protection system, control rod drive system description and analysis, jet pump development, core spray test program, and earthquake design criteria. (M.L.S.)

**46888** (DOCKET-50300–4) [EASTON NUCLEAR STATION]: APPLICATION FOR LICENSES. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Aug. 1, 1967. 31p. Dep. CFSTI.

The application for license for Easton Power Reactor is presented. Included in this application are lists of directors and other executive officers and the Niagara Mohawk Power Corporation 1966 Annual Report. (M.L.S.)

**46889** (DOCKET-50300–5) EASTON NUCLEAR STATION. Preliminary Safety Analysis Report, Vol. 1, Exhibit B. (Niagara Mohawk Power Corp., Syracuse, N. Y.). [1967]. 523p. Dep. CFSTI.

Information on Easton Power Reactor is given under the following broad topics: Introduction and Summary; Site and Environment; Buildings and Structures; Reactor Core and Internals; Reactor Coolant System; Containment Systems; Engineered Safeguards; Control and Instrumentation; Electrical Systems; Reactor Auxiliary and Emergency Systems; Steam and Power Conversion System; Radiological Controls; Conduct of Operations; Initial Tests and Operation; and Safety Analysis. Appendices contain information on: the control rod drive system description and analysis, jet pump development, core cooling test program, and core thermal design. (M.L.S.)

**46890** (DOCKET-50300–6) EASTON NUCLEAR STATION. Notice of Withdrawal of Application for Utilization Facility License. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Aug. 20, 1968. 4p. Dep. CFSTI.

Niagara Mohawk's letter of intent of withdrawal of their license application for Easton Power Reactor and the USAEC's formal acceptance are included. (M.L.S.)

**46891** (DOCKET-50309–15) MAINE YANKEE ATOMIC POWER STATION. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Aug. 16, 1968. 83p. Dep. CFSTI.

The safety evaluation of the Maine Yankee Power Reactor by the AEC, Division of Reactor Licensing, is given. Information is included on: site and environment, reactor design, plant design, accident analysis, research and development, technical qualifications, quality assurance, emergency planning, conformance with AEC General Design Criteria, common defense and security, and ACRS report. (M.L.S.)

**46892** (DOCKET-50313–11) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Suppl. 9. (Arkansas Power and Light Co., Little Rock). Aug. 30, 1968. 21p. Dep. CFSTI.

Information on the quality control program for the containment systems for the Russellville Power Reactor is given. The engineering standards for NDT for the primary piping system are described. Design wind-loading and tornado criteria are detailed. (M.L.S.)

**46893** (DOCKET-50324–1) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 1. (Carolina Power and Light Co., Raleigh, N. C.). July 31, 1968. 600p. (DOCKET-50325–1). Dep. CFSTI.

Information on the Brunswick Power Reactor, Units 1 and 2, is given under the following broad topics: Introduction and Summary; Site and Environs; Reactor; Reactor Coolant System; Plant Structures and Containment Systems; and Engineered Safety Features including core standby cooling systems, main steam line flow restrictors, control rod velocity limiters, control rod drive housing supports, reactor standby liquid control system, and containment atmospheric control system. (M.L.S.)

**46894** (DOCKET-50324–2) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 2. (Carolina Power and Light Co., Raleigh, N. C.). July 31, 1968. 561p. (DOCKET-50325–2). Dep. CFSTI.

Information on Brunswick Power Reactor, Units 1 and 2, is given under the following broad topics: Instrumentation and Control Systems; Electrical Power Systems; Radioactive Waste Control Systems; Auxiliary Systems; Power Conversion Systems; Operations; Outline of Proposed Technical Specifications; and Plant Safety and Accident Analyses including incident analyses, design basis accident analyses and excursion analysis. (M.L.S.)

**46895** (DOCKET-50324–3) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 3. (Carolina Power and Light Co., Raleigh, N. C.). July 31, 1968. 487p. (DOCKET-50325–3). Dep. CFSTI.

Information on Brunswick Power Reactor, Units 1 and 2, is given under the following headings: site and environs supporting reports including material on geology, seismology, hydrology, and meteorology; jet pump development program; core spray test program; and comparative evaluation with AEC Design Criteria. (M.L.S.)

**46896** (DOCKET-50249–3) DRESDEN NUCLEAR POWER STATION, UNIT 3. VOLUME II. PLANT DESIGN AND ANALYSIS

REPORT. (Commonwealth Edison Co., Chicago, Ill.). Feb. 14, 1966. 181p. Dep. CFSTI.

A complete set of engineering drawings for Dresden Power Reactor, Unit 3 are given. Also included are: the jet pump design and development program, control rod drive system description, discussion of excursion damage limits, discussion of hypothetical nuclear excursion accidents, and stability. (M.L.S.)

**46897** (EURFNR-497) DEVELOPMENT OF A COMPLETELY HYDRAULICALLY ACTUATED AND CONTROLLED SHUTDOWN AND CONTROL SYSTEM FOR WATER AND STEAM-COOLED REACTORS. Muehlaeuser, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Translated from report KFK-665. 39p. (EUR-3699). Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A description is presented of a completely hydraulic control rod drive system, in which control rod movement is actuated and recorded hydraulically. The control rod is moved by a hydraulic piston motor of conventional design. The drive system incorporates a clamp which reacts to the coupling pulses of the follower hydraulic and precludes accidental uncontrolled insertion of the control rod into the core. Also described for the system are a fast valve, a braking-damping spring set, potentiometer, and piston motor and clamp. (auth)

**46898** (HPR-101) FINAL REPORT ON IFA-10, THE FIRST SWEDISH INSTRUMENTED FUEL ASSEMBLY IRRADIATED IN HBWR, NORWAY. Gyllander, J.-A. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Aug. 1968. 35p. Dep.

A final report is presented on IFA-10, the first Swedish instrumented fuel assembly irradiated in HBWR. The post-irradiation data are presented and correlated with the irradiation statistics. No bowing of the bundle was observed, no equi-axed grain growth was discernible, the fission gas release was very small, and the relative dimensional changes in length and diameter were of the order of magnitude $9 \times 10^{-4}$. The hydride content of the can increased from 35 ppm to 65 ppm and, in the contact point of the spacer, to 180 ppm. (auth)

**46899** (IFA-TR-55) EVALUATION OF SPECIFIC POWER FOR GLASSY CERAMIC FUEL ELEMENTS. Lungu, S. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 9p. (In French). Dep.

Heat transfer characteristics and temperature distributions for a vitreous-ceramic fuel for a high temperature gas cooled reactor are determined. The equations for the temperature distributions are derived. (M.L.S.)

**46900** (JUL-521-RG) UEBERWACHUNG DER PROJEKTIERUNGSARBEITEN BEI KERNKRAFTWERKEN DURCH EIN RECHENPROGRAMM. (Control of Planned Work at a Nuclear Institution Through a Computer Program). Luetkens, Luer (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar. 1968. 150p. (In German). Dep.

A computer program was developed for assistance in the planning of the THTR (Thorium High Temperature Reactor) nuclear power plant. All important data of the power plant can be stored in one of the programs developed by Diehl. The complete project was classified into "items," which are technical groups, as building groups. For each item, a catalog structure was constructed. These contain a name, a describing text and attributes with names, values, dimensions, etc. The values can be located and used for calculations. The program is in position to detect errors in the planning. By means of simple commands various extracts and surveys can be prepared from the data. The program can be used as a central information site. There is no definite length for the list structure and any information can be altered or erased if necessary. (tr-auth)

**46901** (JUL-528-RW) ON THE RADIATION DAMAGE TO THE SOLIDITY OF BeO MODERATOR ELEMENTS IN A THERMAL HIGH-TEMPERATURE REACTOR. Buresch, F. E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). June 1968. 16p. (In German). Dep.

Radiation effects on beryllium oxide moderator materials for high temperature breeder reactors are determined. The tensile properties of irradiated and unirradiated beryllium oxide are described; analytical expressions for these are given. Tensile strength is shown as a function of grain size for ratios of apparent density/theoretical density. 11 references. (M.L.S.)

**46902** (JUL-542-RG) USE OF THE PLUTONIUM ACCUMULATION PRINCIPLE IN THE PEBBLE-BED HIGH-TEMPERATURE REACTOR. Babac, Tuncay (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). July 1968. 90p. (In German). Dep.

The calculational procedures for determining Pu buildup in a pebble bed reactor are described. Concentration balances are given for a pebble bed reactor; these include burnup, heavy metal isotopes, and fission product balances. Analytical expressions are given for the resonance integral and resonance cross section; temperature effects on resonance cross section are considered. Coolant temperature distributions are discussed. Power and temperature profiles of pebble fuel elements are described in detail. The thermal neutron self-shielding factor is defined. Design parameters for a reference pebble bed reactor are listed; effects of Pu buildup are considered. Calculations made for one- and two-zone reactors are tabulated; fuel cycle costs are calculated. 33 references. (M.L.S.)

**46903** (MIT-2073-7) THE EFFECT OF $^{236}U$ AND $^{237}Np$ ON THE VALUE OF URANIUM USED AS FEED FOR THERMAL POWER REACTORS. Benedict, Manson; Bauhs, David J.; Golden, Terence C.; Mason, Edward A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). June 30, 1968. Contract AT(30-1)-2073. 184p. (MITNE-94). Dep. CFSTI.

Application of a previously described method for calculating the effect of $^{236}U$ and $^{237}Np$ on the value of uranium is extended to a heavy water reactor and to a pressurized water reactor whose spent uranium is then fed to a heavy water reactor. The heavy water reactor used is a 1073 MW(e) uranium carbide-fueled, organic-cooled reactor, and the pressurized water reactor used has the characteristics of the 430 MW(e) San Onofre reactor. The economic parameters used are described, and the cost calculations and uranium values obtained for the two reactor types are presented and discussed. (H.D.R.)

**46904** (N-68-24779) CALCULATION OF NEUTRON SPECTRA IN THERMAL REACTORS BY MEANS OF VARIOUS CODES. Orestano, F.; Pistella, F. Translated from an Italian report. 24p. (NASA-TT-F-11671). CFSTI.

In order to study and interpret experimental data on water-moderated Pu lattices a special method for neutron spectra evaluation is developed by combining existing codes. (auth)

**46905** (NP-17599) BRITISH NUCLEAR POWER PLANT. ([United Kingdom Atomic Energy Authority, London (England)]). [1968]. 44p. Dep.

Separate abstracts are included for all 5 of the 5 papers presented on the development of U.K. gas-cooled reactors. (D.C.C.)

*For abstracts of individual papers see: 47045, 46906, 46908, 46907, and 46909.*

**46906** (NP-17599, pp 1-6) PROGRESS IN THE EXPLOITATION OF THE GAS-COOLED REACTOR. Brown, Gordon; Insch, G.; Wagstaff, C. V.

The main operational and safety features of an AGR power station are presented. Developments in the construction of the Dungeness B, Hinkley Point 2 and Hunterston B power stations are described. A brief description of an export version of an AGR is presented. (D.C.C.)

**46907** (NP-17599, pp 7-25) THE PERFORMANCE OF THE CENTRAL ELECTRICITY GENERATING BOARD NUCLEAR POWER STATIONS. Silverleaf, D. J.; Weeks, R. J.

A description is presented of the operational performances for Berkeley, Bradwell, Hinkley Point A, Trawsfynydd, Dungeness A, Sizewell, and Oldbury power stations. The performance descriptions include maintenance, power output, economics, fuel cycle efficiency, and fuel failures. (D.C.C.)

**46908** (NP-17599, pp 26-9) THE DESIGN, COMMISSIONING, AND OPERATION OF THE STEAM GENERATING HEAVY WATER REACTOR. Cartwright, H.

A brief description is presented of the operation development schedule for the Winfrith SGHWR. The description includes prestartup testing, raising to power, and operation at power. (D.C.C.)

**46909** (NP-17599, pp 30-40) PLACE OF THE FAST REACTOR IN COMMERCIAL POWER DEVELOPMENT. Marsham, T. N.

Comparisons are presented for fuel cycle performances of 1000 MW(e) gas-cooled thermal reactors, water-cooled thermal reactors, and fast reactors. The future possibilities for commercial fast reactor development in U.K. are described. (D.C.C.)

**46910** (ORNL-4265) LOFT ASSISTANCE PROGRAM IN ENGINEERING DEVELOPMENT AND NUCLEAR SAFETY TESTS AT

THE OAK RIDGE NATIONAL LABORATORY. Parker, G. W.; Matheney, G. B.; Adams, R. E. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 75p. Dep. CFSTI.

The LOFT Assistance Program at ORNL is designed to provide numerical data needed to develop and evaluate analytical models for predicting release, transport and containment behavior of fission products in the safety analysis of water reactors. The status of the LOFT Assistance Program after three years and the requirements for its reorientation in support of the LOFT Emergency Core Coolant Systems Tests are reviewed. (auth)

**46911** (ORNL–4266) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1968. Savolainen, Ann W. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 235p. Dep. CFSTI.

REACTORS, GAS-COOLED — fuel reprocessing studies for, silicon carbide coatings depositions for; fuel elements for, bonding of coated particles for; fuel elements for high temperature, performance during irradiation of; fuel cycle economics for high temperature; reactor vessels for, summary of model studies for prestressed concrete

REACTOR FUELS — reprocessing studies for gas cooled, silicon carbide coatings depositions for; preparation of coated particle, HFIR irradiation design parameters for; radiation effects testing of pyrolytic carbon coated microsphere, high temperature fast neutron; coatings for, eddy current techniques for measurement of anisotropy of pyrolytic carbon; fission product release from high burnup coated particle, use of post irradiation annealing for; fission product transport and deposition measurements for gas cooled; compatibility with water vapor of silicon carbide coated; carbon coatings for, reaction rate determination for steam and

REACTOR FUEL ELEMENTS — coated particles for gas cooled, bonding of; radiation effects testing of high-temperature gas cooled

ORNL RESEARCH REACTOR — radiation effects experiments in, performance of high burnup coated particle fuels during

ORNL HIGH FLUX ISOTOPES REACTOR — radiation effects experiments in, performance of bonded bed and coated particle fuels during

COATINGS — anisotropy of pyrolytic carbon fuel, eddy current techniques for measurement of; creep of spherical anisotropic pyrolytic carbon, stress-strain equations for calculating (M.L.S.)

**46912** (ORNL-NSIC–25) AIR CLEANING AS AN ENGINEERED SAFETY FEATURE IN LIGHT-WATER-COOLED POWER REACTORS. Keilholtz, G. W.; Guthrie, C. E.; Battle, G. C. Jr. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 127p. Dep. CFSTI.

The safety features of air-cleaning systems for use after postulated loss-of-coolant accidents or other design-basis accidents in water-cooled power reactors are discussed. The capabilities and limitations of high-efficiency air filters and charcoal adsorbers both in recirculating systems and in once-through systems are reviewed. The air-cleaning potentials of contaminated-cooling sprays and pressure-suppression pools are also discussed. Important considerations in the use of air cleaning systems as engineered safety features are their effectiveness and their performance under accident conditions, including radiation, thermal transients, abnormal pressures, pressure surges, missiles, and corrosion. To be effective as an engineered safety feature, an air-cleaning system must either rapidly reduce the fission-product concentration in the containment shell or efficiently trap fission products that have leaked from the containment shell into the secondary container. The most widely used methods provided for treating fission products after an accident are trapping of particulates by prefilters and HEPA filters, trapping of $I_2$ by activated charcoal, and retention of noble gases until they have decayed to acceptable levels, followed by gradual, controlled release from a tall stack. At the present time filter systems are further developed and more generally accepted as an engineered safety feature than containment sprays, but current research may show that sprays may be more desirable, especially for iodine removal. 158 references. (auth)

**46913** (ORNL-NSIC–26) TESTING OF CONTAINMENT SYSTEMS USED WITH LIGHT-WATER-COOLED POWER REACTORS. Zapp, Frank C. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 258p. Dep. CFSTI.

An evaluation of the testing of containment systems used with light-water-cooled nuclear power reactors was made through discussions with members of the nuclear power industry and studies of published literature, reports of leakage-rate tests, technical specifications, and information available in preliminary and final safety analysis reports and their supplements. Conclusions are presented relative to leakage-rate test results, continuous leakage-rate monitoring, and developments that may affect future testing requirements. Also, recommendations are made relative to proposed codes, standards, and guides; isolation-valve testing; containment air-cooling and spray systems testing; and containment systems testing research programs. 92 references. (auth)

**46914** (ORNL-NSIC–27) REVIEW OF METHODS OF MITIGATING SPREAD OF RADIOACTIVITY FROM A FAILED CONTAINMENT SYSTEM. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 103p. Dep. CFSTI.

A summary of methods available for preventing the spread of radioactivity following a hypothetical containment system failure is given. Control measures available for application, both internal and external, to the containment vessel are reviewed; recommendations for future studies are given. 97 references. (M.L.S.)

**46915** (ORNL-TM–2218) CALCULATING CONVECTIVE TRANSPORT AND DEPOSITION OF FISSION PRODUCTS. Kress, T. S.; Neill, F. H. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Some calculational techniques used in the HTGR Fission Product Deposition Program are presented. A method of solution of the differential equations for a Langmuir Adsorption Isotherm surface condition is suggested and approximate numerical results are presented. An exact solution is presented for fission products condensing on a surface. This solution is directly applicable to thermal gradient tubes. These two solutions are shown to be in good agreement with limited experimental data. (auth)

**46916** (ORNL-TM–2245) REMOVAL OF $^{135}Xe$ FROM CIRCULATING FUEL SALT OF THE MSBR BY MASS TRANSFER TO HELIUM BUBBLES. Peebles, F. N. (Oak Ridge National Lab., Tenn.). July 23, 1968. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Removal of dissolved $^{135}Xe$ by mass transfer to He bubbles offers an attractive means of controlling the $^{135}Xe$ poison level in molten salt breeder reactors (MSBR's). In order to provide necessary engineering information for evaluation of the proposed method, the existing data on rates of mass transfer to gas bubbles have been reviewed. Rather extensive literature references point to reliable equations for prediction of mass transfer rates to single bubbles rising in stationary liquids under the two extreme cases of a rigid bubble interface and of a perfectly mobile bubble interface. In general, experimental data are available which support these predictions. No reliable criterion for predicting the transition from one type behavior to another is available. An elementary analysis of the rates of mass transfer to bubbles carried along by turbulent liquid in a pipe is presented. The results indicate that the bubble mass transfer coefficient for 0.02 in. diameter bubbles will be approximately 13 ft/hr for mobile-interface bubbles, and approximately 2 ft/hr for rigid-interface bubbles. An experiment is suggested to provide specific data on the mass transfer rates to bubbles carried along by turbulent liquid in a pipe for hydrodynamic conditions which simulate the MSBR. 21 references. (auth)

**46917** (ORNL-TM–2304) MSRE DESIGN AND OPERATIONS REPORT. PART XI-A. TEST PROGRAM FOR $^{233}U$ OPERATION. Engel, J. R. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 18p. Dep. CFSTI.

The initial critical experiment with the MSRE containing a complete $^{233}U$ core is described. The calculational techniques used to predict the critical U concentration in the MSRE are analyzed. The loading sequence and power operation of the reactor are described. (D.C.C.)

**46918** (TID–8200(18th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF JUNE 30, 1968. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 34p. Dep. CFSTI.

A compilation is presented of unclassified information about facilities built, being built, or planned in the United States for domestic use or export as of June 30, 1968, which are capable of sustaining a nuclear chain reaction. Information is presented in five parts, each of which is categorized by primary function or purpose. (auth)

**46919** (TID–24662) A GUIDE FOR THE LICENSING OF FACILITY OPERATORS, INCLUDING SENIOR OPERATORS. (Division of Reactor Licensing (AEC), Washington, D. C.). Nov. 1965. 61p. GPO $0.40.

A complete guide for reactor operator and senior operator licensing is given. Those sections of 10 CFR which are applicable to operator licensing are included. Typical samples of questions for operator and senior operator exams are given. (M.L.S.)

**46920** (TID-24679(Vol.1)) THE STATE OF TECHNOLOGY OF FUELLING SYSTEMS FOR HEAVY WATER REACTORS AND A PROGRAM FOR FURTHER RESEARCH AND DEVELOPMENT. VOLUME ONE. (Dilworth, Secord, Meagher and Associates Ltd., Toronto (Ontario)). May 1968. 99p. Dep. CFSTI.

For Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

The salient features of fuelling systems for seventeen heavy water reactors, fifteen of them being of the pressure-tube type and the remaining two being European pressure-vessel reactors, are presented. The "state-of-the-art" is determined for vital elements and assemblies of each fuelling machinery complex. A "merit rating" has been drawn up for the fuelling systems of four existing pressure tube reactors, and trends are discerned in the probable evolution of overall fuelling machinery layout and mechanism design. A detailed research and development program is presented, which if implemented, will improve and develop those features which are thought to require further effort. The program identifies specific areas of conceptual design of the overall fuelling system, together with particular mechanisms or devices requiring more intensive study. A cost estimate and time schedule are suggested for the program, which would entail $5,520,000 spread over four years. (auth)

**46921** (TID-24679(Vol.2)) THE STATE OF TECHNOLOGY OF FUELLING SYSTEMS FOR HEAVY WATER REACTORS AND A PROGRAM FOR FURTHER RESEARCH AND DEVELOPMENT. VOLUME TWO. (Dilworth, Secord, Meagher and Associates Ltd., Toronto (Ontario)). May 1968. 191p. Dep. CFSTI.

For Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

Descriptions of each of the seventeen heavy water-moderated reactors and their fueling systems are presented. Eleven pressure-tube reactors fueled on-power are described. Four pressure-tube reactors fueled off-load are described. Also, two pressure-vessel reactors using on-power fueling are described. (auth)

**46922** (TRG-Report-1686) THE DESIGN, COMMISSIONING AND OPERATION OF THE S.G.H.W.R. Cartwright, H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 5p. (CONF-680625-1). Dep. CFSTI. UK 1s. 0d.

From BNX/BNF Nuclear Power Meeting, Copenhagen, Denmark.

A description of pre-startup testing, raising to power, and operation at power of the Winfrith SGHWR is presented. (D.C.C.)

**46923** (UNC-5219) FAST REACTOR MIXED CARBIDE FUEL ELEMENT DEVELOPMENT. SAFETY ANALYSIS REPORT OF IRRADIATION CAPSULES UNC 125 THROUGH UNC 128. Rosh, D. M. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). July 29, 1968. Contract AT(30-1)-3415. 75p. Dep. CFSTI.

Descriptions of the Type 304 stainless steel- and Incoloy 800-clad PuC - UC and mixture of PuC - UC and $Pu_2C_3 - U_2C_3$ fuel capsules are presented. Thermal properties and stress analysis for the capsules are determined by computer program as a safety precaution prior to irradiation in inner pool of the GETR. (D.C.C.)

**46924** (WAPD-MRP-125) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, April 27-July 26, 1968. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 48p. Dep. CFSTI.

An operations history of Core 2 Seed 1 for Shippingport Power Reactor is given. Results of detailed physics measurements and calculations are described. Ultrasonic inspection of the steam generator tubes is described; results are given. Structural integrity of the Seed 2 fuel assemblies is evaluated. Irradiation testing of Seed 2 fuel elements is described; results are discussed. Steady state and transient design limits for the fuel elements are determined. (M.L.S.)

**46925** (WARD-3791-19) VANADIUM ALLOYS VERSUS STAINLESS STEEL FOR LMFBR CLADDING: PERFORMANCE AND ECONOMICS. Edison, G.; Harrill, R.; Schwartz, E. S.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). July 1968. Contract AT(30-1)-3791. 62p. Dep. CFSTI.

A comparison of economics and performance is made for vanadium alloy and stainless steel cladding in a carbide-fueled LMFBR. For a core coolant outlet temperature of 1000°F, the power cost with vanadium alloy cladding is about 0.07 to 0.09 mills/kWh higher than with stainless steel cladding. When the core coolant outlet temperature is raised to 1100°F for those core designs with vanadium alloy cladding, the power cost with vanadium is about 0.02 to 0.05 mills/kWh higher than with stainless steel. The power costs depends strongly on the projected fabrication cost of vanadium alloy and stainless steel tubing. Several fabrication costs are considered, as well as different cladding thicknesses. Differences in nuclear performance characteristics such as fuel inventory breeding ratio, and doubling time are less than one percent for all cladding materials and thicknesses studied. Doppler and sodium-void reactivity effects are five to ten percent more favorable with vanadium alloy cladding than with stainless steel. Based upon the available economic and performance data, a vanadium alloy appears to be an attractive first alternate to stainless steel for LMFBR cladding. (auth)

**46926** (WARD-3843-1) SUPERCRITICAL LOOP EXPERIMENTAL TEST PROGRAM. Cohen, Paul (ed.) (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1968]. Contract AT(30-1)-3843. 53p. Dep. CFSTI.

The design revisions, construction and checkout of the Saxton Supercritical Loop are described. Results are presented of the irradiation in the Saxton Reactor of an Incoloy-800 clad, $UO_2$ pellet-fueled, seven-rod fuel assembly in supercritical water at 3600 psia and 830-900°F clad temperature. Observations on ammonia dissociation and fission product release from a failed fuel rod are presented. Post-irradiation examination results on the fuel bundle are presented and possible mechanisms for the cladding failure are discussed. (auth)

**46927** (WASH-1102) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 2. PLANT DESIGN. (Argonne National Lab., Ill.). Aug. 1968. 197p. Dep. CFSTI.

The plant design section of the LMFBR program plan deals with the development of plant concepts and an LMFBR technology for plant design that will ensure: attainment of safe, reliable, and economically competitive LMFBRs; and full utilization of natural resources. The plant design program describes the development and demonstration of LMFBR plant concepts for central-station use, together with the required technology. (auth)

**46928** (WASH-1106) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 6. CORE DESIGN. (Argonne National Lab., Ill.). Aug. 1968. 333p. Dep. CFSTI.

The core design section of the LMFBR program discusses the technology needed to design safe, reliable, and economic cores for LMFBRs. The core design technology includes near-term core for the FTR and first generation of demonstration plants, intermediate-term improved cores for demonstration plants and economically competitive LMFBR central-station power plants, and long-term improved cores of optimum economic operation of LMFBR central-station power plants. (auth)

**46929** (WASH-1109) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 9. PHYSICS. (Argonne National Lab., Ill.). Aug. 1968. 294p. Dep. CFSTI.

The physics section of the LMFBR program provides the development of analytical methods and supporting experimental results required to confidently design a practical commercial LMFBR. The physics program includes all work required for the development of commercial LMFBRs that deals with the interactions of neutrons and $\gamma$ radiation with reactor materials. (auth)

**46930** (WASH-1110) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 10. SAFETY. (Argonne National Lab., Ill.). Aug. 1968. 256p. Dep. CFSTI.

The safety section of the LMFBR program is technologically oriented to aid designers, operators and regulatory groups in achieving and substantiating the requisite level of safety for LMFBRs. The LMFBR safety program includes evaluations and experimentation relative to abnormal operation, potential accidents, safety systems designed to prevent accidents and to limit their consequences, development and testing of accident analysis methods, and development and testing of containments. (auth)

**46931** I FATTORI TECNOLOGICI DETERMINANTI DELL'-EVOLUZIONE DEI REATTORI DI POTENZA E LORO INFLUENZA SULL'ESPANSIONE DEI PROGRAMMI ELETTRONUCLEARI. Atti del XII Congresso Nucleare Organizzato dal Forum Italiano dell'Energia Nucleare, Roma, 27-28 Giugno 1967. (Determination of Technological Factors in the Development of Power Reactors and Their Influence on the Expansion of the Electronuclear Program. Proceedings of the 12th Nuclear Congress for Italian Forum on Nuclear Energy, Rome, June 27-28, 1967). Rome, Comitato Nazionale Energia Nucleare, 1968. 351p. (CONF-670639).

Technical and economic factors influencing the worldwide de-

velopment of nuclear power plants are reviewed in 16 papers. Separate abstracts were prepared for 14 papers. Two papers were previously abstracted for NSA and appear under CONF-670639 in the report number index. (H.D.R.)

*For abstracts of individual papers see: 46932, 46939, 45150, 46933–46938, and 46942–46946.*

**46932** THE TECHNOLOGICAL FACTORS DETERMINING THE DEVELOPMENT OF POWER REACTORS AND THEIR OVERALL INFLUENCE ON THE EXPANSION OF THE ELECTRONUCLEAR PROGRAM. Angelini, Arnaldo M. pp 33-52 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968. (In Italian).

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

A general outline of the history and development of nuclear energy is given. Production of electricity from present-day power reactors is discussed; plans for future world-wide nuclear power production are reviewed. The role of nuclear fuels and fuel cycles in the economics of the nuclear industry is discussed. Overall economic and development aspects for a world-wide nuclear industry are evaluated. (M.L.S.)

**46933** TECHNOLOGICAL PROGRESS IN THE DESIGN AND CONSTRUCTION OF NUCLEAR POWER PLANTS IN GERMANY. Kornbichler, Heinz (Deutches Atomforum, Bonn). pp 309-16 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

German activities in the development of power reactors are described, and some of the results which have been achieved are reported. Emphasis in development has been placed on light water reactors, heavy water reactors, high temperature gas cooled reactors, advanced gas cooled reactors, and fast breeders, respectively. (H.D.R.)

**46934** PRESENT STATUS AND PROSPECT OF NUCLEAR DEVELOPMENT IN JAPAN. Miyanaga, Ichiro (Japan Atomic Industrial Forum, Inc., Tokyo). pp 317-27 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

The current status of atomic power development in Japan in terms of government and industry policies and projects is presented. Power reactor projects scheduled for construction by 1975 are tabulated, and the outlook for reactor development and fuel requirements up to the year 2000 is examined. (H.D.R.)

**46935** PROGRESS AND DEVELOPMENT IN THE FIELD OF NUCLEAR DESIGN AND CONSTRUCTION IN ITALY. Riccio, Giorgio. pp 329-43 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968. (In Italian).

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

The status of nuclear power development in Italy is reviewed, and the capacity of Italian industry in the design and fabrication of fuel elements and reactor components and in fuel reprocessing are discussed. Trends in power reactor development in Italy are examined. (H.D.R.)

**46936** EXAMPLES OF THE TECHNOLOGICAL PROGRESS ON THE OCCASION OF THE REALIZATION OF THE EL-4 REACTOR. Gibrat, R.; Dupuy, J. C. pp 253-67 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968. (In French).

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

The EL-4 reactor is described. Utilization of $CO_2$ coolant at high temperature and pressure is discussed; use of zircaloy for reactor internals is evaluated. Automation of control and safety circuits is detailed; schematics are shown. Control of absorbed gases in the system is discussed. (M.L.S.)

**46937** PROGRESS OF NUCLEAR FUEL TECHNOLOGY IN THE UNITED KINGDOM. Griffiths, J. J.; Brennan, K. A. pp 133-50 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Steps followed in the development and fabrication of fuel elements for the Magnox and AGR reactors and the Steam Generating Heavy Water Reactor are reviewed. Fuel management, the refueling scheme, and typical fuel cycle costs for the AGR reactors are discussed, and unique features of the SGHWR fuel elements are described. (H.D.R.)

**46938** TECHNOLOGICAL PROGRESS IN THE FIELD OF NUCLEAR FUELS. PARTS I AND II. Sani, Luciano; Zifferero, Maurizio. pp 89-131 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968. (In Italian).

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

The influence of fuel costs on the economics of nuclear power production is considered; effects of enrichment burnup and plutonium generation on fuel costs are evaluated. The performance of ceramic fuels with respect to energy yield and average specific power is analysed; data are tabulated. Characteristic fuel data are tabulated for BWRs, PWRs, and AGRs. The fuel research programs at Garigliano and Trino are outlined. The reactor fuel utilization program conducted by CNEN is discussed. The fuels research and development program for water cooled power reactors is detailed. (M.L.S.)

**46939** RECENT PROGRESS IN FUEL ELEMENTS. Salesse, M.; Jeanpierre, M.; Sebilleau, F. (CEA, Paris). pp 77-87 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968. (In French).

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Effects of increasing the diameter of the EDF-3 fuel elements are discussed; results are tabulated. The cross section of the Bugey Reactor annular fuel element is shown; the graphite core of the element is described. Variations of fuel element price are shown as a function of time. (M.L.S.)

**46940** INDUSTRIAL NUCLEAR GAS TURBINE POWER PLANTS. Bammert, Karl; Buende, Rolf (Technische Univ., Hanover). Atomkernenergie, 13: 381-3(1968). (In German).

Temperature-entropy diagrams and cycle schemes of He power plants for power and steam generation are given. Single and dual cycle systems are described. Net efficiency of a 300 MWe plant is shown graphically. (M.L.S.)

**46941** HIGH TEMPERATURE GAS-COOLED REACTORS WITH GAS TURBINE. Bammert K. (Technical Univ., Hanover); Boehm, E. Atomkernenergie, 13: 371-6(1968).

In the last few years the development of closed-cycle gas turbines has reached the same technical level as that of steam turbines. Therefore the solution offers itself to combine the high-temperature reactor (HTR) with a He turbine. The direct coupling of reactor and turbine gives a particularly simple cycle and the temperature level of the high-temperature reactor suits the He turbine requirements. The result is a high efficiency and a simpler and smaller plant. (auth)

**46942** PROGRESS IN NUCLEAR STEAM GENERATING SYSTEMS EMPLOYING PRESSURIZED WATER REACTORS. Zinn, Walter H.; Dietrich, Joseph R. (Combustion Engineering Inc., Windsor, Conn.). pp 169-91 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Developments in components and operating practices for plants using pressurized water reactors are reviewed. Principal developments have been in the improvement of thermal performance and in the design and fabrication of large components. The benefits to be expected in plant costs, flexibility of operation, reliability, and

plant availability are discussed for the various areas of improvement. (H.D.R.)

**46943** PROGRESS IN HIGH TEMPERATURE GAS COOLED REACTORS PEACH BOTTOM AND THE 330 MW FORT ST. VRAIN POWER STATION. de Hoffmann, Frederic; Rickard Corwin (General Atomic Corp., San Diego, Calif.). pp 193-214 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

In separate sections, the startup and initial operation of the Peach Bottom reactor and the experimental testing, design, and development work for the Fort St. Vrain reactor are discussed. Characteristics of HTGR plant designs up to 1000 MW(e) are examined, and their potential application for power generation in the 1970's and 1980's is discussed. (H.D.R.)

**46944** TECHNICAL PROGRESS IN THE DESIGN AND CONSTRUCTION OF BOILING WATER REACTOR PLANTS. Richards, R. B. (General Electric Co., San Jose, Calif.). pp 215-37 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Improvements in the simplicity, compactness, and controllability of boiling water reactor power plants now incorporated in plants under construction are discussed. Among the features allowing simplification of reactor systems are the use of a single cycle steam system, the use of jet pumps in recirculation loops, and the development of the pressure-suppression type of containment system. The increase in core power density and improvements in fuel and reactor auxiliary system performance are examined. (H.D.R.)

**46945** STATUS AND TRENDS OF THE WESTINGHOUSE PWR. McGrath, R. G.; Keogh, T. J. pp 239-50 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

Some of the improvements that have been made in pressurized water reactor power plants are summarized. Special features and technical contributions of the San Onofre plant are described. (H.D.R.)

**46946** ASEA BOILING WATER REACTORS FOR LIGHT AND HEAVY WATER. Leine, Lars (ASEA, Vasteras, Sweden). pp 269-83 of I Fattori Tecnologici Determinanti Dell'evoluzione dei Reattori di Potenza e Loro Influenza Sull'espansione dei Programmi Elettronucleari. Rome, Comitato Nazionale Energia Nucleare, 1968.

From 12th Nuclear Congress on Technological Factors Determining the Development and Consequent Expansion of the Use of Power Reactors, Rome, Italy. See CONF-670639.

The operating parameters, design features, and construction status of the Marviken and Oskarshamn power stations are described. The Marviken plant has a direct-cycle boiling heavy-water reactor and the Oskarshamn plant uses a boiling light-water reactor. Development studies on future improvements in both plant types are reviewed. (H.D.R.)

**46947** HINKLEY POINT B: CONSTRUCTION TECHNIQUES. Pearson, R. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng., 13: 654-6(Aug. 1968).

The construction principles and techniques are described. Many major sections of the reactor and pressure vessel are constructed in large prefabricated sections, factory built under better and more economic manufacturing conditions. Rather than resort to giant Goliath cranes, great advantages are gained by using a 600 ton overhead gantry crane, supported on the steelwork of the main building, to lift the prefabricated units into the pressure vessel. (auth)

**46948** HINKLEY POINT B: FUEL HANDLING EQUIPMENT. Fortey, J. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng., 13: 656-8(Aug. 1968).

A single fuel charging machine, based on the design for the Windscale AGR, serves both charge faces of this twin reactor station. The two charge faces are connected by a common charge hall and to the services block with its various shielded cells. Features of the design and fuel handling procedure are deseribed. (auth)

**46949** CHOICE OF INITIAL STEAM CONDITIONS OF FAST BREEDER REACTOR PLANTS. Arsen'ev, Yu. D.; Zakharin, A. G.; Chakhovskii, V. M. At. Energ. (USSR), 25: 107-11(1968). (In Russian).

The initial conditions of the thermodynamic cycle for fast breeder reactor plant are studied. The range of optimum values of the initial steam conditions is established. The results of investigations are recommended for practical application in the design of fast reactor plants. Investigations on the reactor physics and engineering should be carried out with taking into account economically feasible initial steam conditions. (auth)

**46950** THE U. K. FAST REACTOR PROGRAMME. Laithwaite, J. M. pp 43-52 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A description of the fast reactor development program in the U.K. is presented. Developments in fuels, reactor physics, engineering studies, and power costs are presented. A description of the Dounreay Fast Reactor development program is presented. (D.C.C.)

**46951** THE U.S.A. FAST BREEDER REACTOR PROGRAM. Giambusso, A.; Wensch, G. W. pp 31-41 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A description of the liquid metal-cooled breeder reactor development program in the U.S.A. is presented. Developments in fuels, fast reactor physics, and system and component engineering are described. 9 references. (D.C.C.)

**46952** I REATTORI VELOCI. VIII Congresso Nucleare, Rome, Giugno 1963. (Fast Reactors. 8th Nuclear Congress, Rome, June 1963). Rome, Comitato Nazionale Energia Nuclear, 1967. 646p. (CONF-193-(Vol.2)).

Separate abstracts are presented in 24 of the 30 papers included. The 6 remaining papers were previously abstracted and are found in NSA as CONF-193-(Vol. 2) in the report number index. (D.C.C.)

*For abstracts of individual papers see: 45223, 46748-46951, 46953-46956, 46958-46964, 47021-47025, and 47050-47052.*

**46953** STATUS OF THE ENRICO FERMI ATOMIC POWER PLANT. Hartwell, R. W. (Power Reactor Development Co., Detroit). pp 319-41 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A description of the Enrico Fermi Atomic Power Plant is presented. Testing of systems and components and final inspection results are presented. (auth)

**46954** APPROXIMATE CALCULATIONS OF REACTOR TRANSIENT AS APPLIED TO D. F. R. TYPE REACTOR SYSTEMS. Wheeler, R. C. pp 571-91 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

Simple calculations are described for the cases of step reactivity additions, slow ramp reactivity additions, and coolant flow failure. The approximations are applicable to DFR-type reactors but apply generally to reactor systems with two main negative feedback mechanisms, one with a time constant much less than the lumped one delayed neutron group time constant, and one whose time constant is longer. (auth)

**46955** DOPPLER EFFECT OF $^{239}$Pu FOR FAST REACTORS. Fossoul, E. A. pp 181-96 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A mathematical expression for the temperature contribution to the Doppler coefficient of reactivity for $^{239}$Pu in fast reactors is developed; the nuclear constants for $^{239}$Pu are given. Results of numerical evaluation of the equations are tabulated. 10 references. (M.L.S.)

**46956** ANALOG COMPUTER METHOD FOR SOLVING FLUX DISTRIBUTION PROBLEMS IN MULTIREGION NUCLEAR REAC-

TORS. Radanovic, L.; Bingulac, S.; Lazarevic, B.; Matausek, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 197-213 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The use of an analog computer for solving problems concerning the neutron flux distribution in a multiregion fast reactor is described. One-dimensional two group treatment of the radial flux distribution is presented by solution of the appropriate diffusion equations. 6 references. (D.C.C.)

**46957** RELAY PROTECTION OF NUCLEAR REACTOR PLANTS, e.g. FOR THE ATOMIC POWER STATION AT LUCENS, SWITZERLAND. Boeck, G. Bull. Oerlikon, No. 376, 9-16 (Oct. 1967).

A description of protection systems for the electrical circuits in the LUCENS Reactor is presented. Back-up short-circuit and overload protection systems for the reactor systems are illustrated. (D.C.C.)

**46958** COEFFICIENT OF REACTIVITY FOR LARGE POWER REACTORS. Zaleski, C. P. pp 55-89 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The dynamic behavior of fast-Na cooled reactors is considered; three reactivity effects evaluated are the Doppler effect, the fuel dilution effect, and Na void effect. Methods used for the calculation of the Doppler effect and Na void effect are given. The reactivity effects are evaluated for large (on the order of 2500 liters) and small (on the order of 40 liters) cores. Design characteristics of the four reactor models used for reference studies are tabulated. Isothermal coefficients of reactivity are listed for the four reactors; power coefficients are given, also. Reactivity transfer functions are shown graphically; power and reactivity behavior in the event of Na expulsion are evaluated. (M.L.S.)

**46959** TEMPERATURE DISTRIBUTION ACROSS A NUCLEAR REACTOR WITH COOLING CHANNELS. Biasini, L. (CNEN, Bologna). pp 537-45 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The heat transfer equations for fast reactor coolant channels are solved using numerical methods; the assumptions made are listed. The results obtained from the numerical solutions are shown graphically; these are discussed briefly. (M.L.S.)

**46960** SODIUM SYSTEM MAINTENANCE. Morabito, J. J.; Amorosi, A.; Clark, C. H. pp 377-417 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The primary concern in performing maintenance operations on sodium systems include: system contamination, component burning, hazard to personnel, and contamination of replaced component. Procedures and equipment used in sodium system maintenance are described. (auth)

**46961** RELATIVE ECONOMIC POTENTIAL OF FAST $^{233}U$–Th REACTORS. Eggen, D. T.; Stoker, D. J.; Flynn, W. A. (Atomics International, Canoga Park, Calif.). pp 477-91 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

Calculations for determining an optimum fast breeder fuel system are presented. The fuel system considered are $ThO_2$–$^{233}U$, $PuO_2$–$UO_2$, and enriched $UO_2$. 3 references. (D.C.C.)

**46962** DEVELOPMENT OF LARGE SODIUM PUMPS. Wright, J. H. pp 457-76 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The development programs for liquid Na pumps delivering 50,000 to 100,000 gpm are described. Optimizing studies prescribe the selection of a mechanical-type pump with a free surface, shaft seal, centrifugal configuration. A Na pump test facility is described in which prototype and full scale pumps are tested and evaluated. 3 references. (auth)

**46963** SAFETY CONSIDERATIONS IN THE ENRICO FERMI REACTOR DESIGN. Klickman, A. E.; Nims, J. B. Jr.; McCarthy, W. J. Jr.; Nicholson, R. B. pp 593-630 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The general approach taken to guard against severe reactor accidents is described. A hypothetical meltdown accident is postulated and analyzed for energy release and containment requirements. Precautions taken in the design of the Fermi Fast Breeder Reactor to prevent autocatalytic effects and resonance instability are discussed. 17 references. (auth)

**46964** SOME RESULTS OF THE STUDY OF THE SAFETY VESSEL OF THE RAPSODIE REACTOR. Drevon, G.; Falgayrettes, M. pp 631-46 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The evaluation of containment integrity for Rapsodie is discussed. Parameters describing the maximum hypothetical accident used as reference are given. Experiments with a Rapsodie containment mockup are detailed; descriptions of results are tabulated. Application of the results of the mockup experiments to Rapsodie is summarized. Problems and effects of channeling of the Na are described. 5 references. (M.L.S.)

**46965** DEVELOPMENT PROSPECTS OF NUCLEAR ENERGY IN WESTERN EUROPE: AN IMPORTANT REPORT OF THE OECD. Energ. Nucl. (Paris), 10: 249-56(June 1968). (In French).

The predicted power demands for Western Europe are tabulated for the 1970–2010 period. U requirements for power reactors over the decade of the 1970s are tabulated for the various types of reactor. The use of recycle Pu fuel is discussed. Fuel requirements and availabilities are tabulated according to reactor type. (M.L.S.)

**46966** HINKLEY POINT B. Nucl. Eng., 13: 652-3(Aug. 1968).

The design of the second commercial AGR power station (2 × 625 MW(e)) is summarized. The design differs from that of Dungeness "B" in having a steam temperature of 541°C instead of 565°C, the gas pressure is increased from 34 to 43 kg/cm$^2$, and the circulators are designed to be removable while the reactor is under pressure. The inclusion of a shield wall between the core and boilers allows a reduction in vault dimensions. (UK)

**46967** THE WORLD'S REACTORS, NO. 43: HINKLEY POINT B. Nucl. Eng., 13: 660(Aug. 1968).

A pull-out sheet gives a cut-away view of the reactor, and shows the design and layout. The main parameters are listed. (UK)

**46968** HINKLEY POINT B: STATION CONTROL AND INSTRUMENTATION. Makin, J. E. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng., 13: 663-5(Aug. 1968).

The computer control system described represents a logical development of the alarm analysis system used at Oldbury. It replaces a large amount of conventional instrumentation and reduces the size of the control room by a factor of three. (auth)

**46969** HINKLEY POINT B: REACTOR CORE AND INTERNAL SHIELDS. Kline, R. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng., 13: 666-8(Aug. 1968).

The core design principles are discussed, and a description is given of the support structure, core brick arrangement, and neutron shield. Details are given of the gas flow paths through the core, and of the boiler shield wall which is constructed of $Ca(OH)_2$ filled tubes. (UK)

**46970** HINKLEY POINT B: TURBINES AND GENERATORS. Harris, F. R.; Creek, F. R. L. (General Electric Co., Ltd., Wembley, Eng.). Nucl. Eng., 13: 661-3(Aug. 1968).

The two 660 MW turbines, designed for TSV conditions of 2,300 psig, 538°C, with reheating to 538°C, have five cylinders and six exhausts, and incorporate integral condensers. The steel foundations and the use of packaged units in construction are discussed. A description is given of the generator and exciter. (UK)

**46971** HINKLEY POINT B: CIVIL ENGINEERING. Hay, J. D. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng., 13: 659-60(Aug. 1968).

Major civil works were located so as to avoid a geological fault running across the site. The results of site investigations and the positioning of the foundations are summarized. A description is given of the reactor building, prestressed concrete pressure vessels, turbine house, and circulating water system. (UK)

**46972** NUCLEAR POWER GENERATION. Fujii, Takashi (Ministry of International Trade and Industry, Japan); Kagayama, Tadashi. Denki Gakkai Zasshi, 88-4: 553-92(Apr. 1968). (In Japanese).

Five articles are given as a feature of the April 1968 issue of

JIEEJ: the long-range program for the development of nuclear power generation, and associated problems; experiences of the operation of the JAPC Tokai power station (a Calder Hall type reactor with 166 MWe); construction of the JAPC Tsuraga power station (a BWR type reactor with 300 MWe); construction of the TPC Fukushima power station (BWR type reactors with 400 MWe and 784 MWe respectively); and, construction of the KPC Mihama power station (PWR type reactors with 500 MWe). (NSA of Japan)

**46973** MOLTEN SALT BREEDER REACTOR AND FUEL CELL FOR USE THEREIN. Bettis, E. S. (to United States Atomic Energy Commission). U. S. Patent 3,403,076. Sept. 24, 1968.

A molten-salt-fueled nuclear breeder reactor comprises a multiplicity of graphite fuel cells anchored at their lower ends only. Inner and outer flow channels extend axially through each fuel cell, terminating at their upper ends in a common plenum within the fuel cell and communicating with respective inlet and outlet plenums at their lower ends. Radial support is provided to a bundle of such fuel cells defining an active core region by graphite spheres buoyed in the blanket region surrounding the bundle. Reactivity control is provided by selectively displacing molten salt containing fertile material from a channel in the active core region. (AEC)

**46974** COMPACT NUCLEAR REACTOR HEAT EXCHANGING SYSTEM. Ruppen, Edward W. Jr. (to Westinghouse Electric Corp.). U. S. Patent 3,395,076. July 30, 1968. Filed Feb. 23, 1966.

A nuclear steam generating system is disclosed which is compact, and can therefore be sealably enclosed within a vapor container of reduced size and cost. An elongated vertically mounted reactor vessel is communicably coupled by concentric inlet and outlet conduits to an elongated horizontally mounted two-pass heat exchanger. The fluid moving unit for this steam generating equipment has its circulating means mounted within the heat exchanger, and is mounted in the same horizontal plane and longitudinally aligned with the heat exchanger thereby reducing the size, cost, and differential expansion problems of the system. (Offic. Gaz.)

**46975** TEST OF THE FUEL GRAB CONSTRUCTED IN TRIAL. Yukishima, Itsuo (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 48, 248-51 (Feb. 1968). (In Japanese).

The grab is used in exchanging fuels in a gas-cooled reactor while in operation, and its reliability in this situation is a problem due to the stringent surrounding condition and to its complicated mechanism. Test results are described. The grab operated satisfactorily under high temperature 450°C, by having clearances of thickness 0.05 to 0.1 mm, and of 0.15 to 0.2 mm where load is applied at the slides. Also, the difficulties due to its complexity were clarified, providing useful information for its future improvement. (NSA of Japan)

**46976** REACTOR DYNAMICS AND CONTROL: STATE SPACE TECHNIQUES. Weaver, Lynn E. New York, American Elsevier Publishing Company, Inc., 1968. 316p. (TID-24674).

The state-variable approach to the solution of problems arising in reactor dynamics and control is detailed. Chapters of the text book include: System Representation in State Space – State variables vector-matrix differential equations, system representation in state variables, determination of state-transition matrix, and state-space trajectories; Equations of Reactor Dynamics; Stability in State Space; Stability of Nuclear Systems; Optimization in the State Space; Closed-Loop Optimal Control; Optimal Control of Nuclear Systems; Control System Design by State-Variable Feedback; and State-Variable-Feedback of Reactor Control Systems. Appendixes are titled, Root-Locus Method, and A Digital Computer Program for the Analysis and Design of State-Variable Feedback Systems. (94 references) (M.L.S.)

**46977** COOLANT PRESSURE CONTROL IN NUCLEAR REACTOR FUEL CHANNELS. Angelini, A.; Dufresne, J. (to EURATOM). Canadian Patent 785,878. May 21, 1968. Priority date Apr. 11, 1963, Belgium.

A method is described for preventing pressure drop in the coolant of a liquid cooled reactor having vertical fuel channels and downward flow. A pressurizing enclosure containing both liquid and gas under pressure is connected to the fuel channels and calandria tubes. By means of flow regulating valves, liquid rises to the same level in the pressuring enclosure as in the calandria tubes because the bottoms of the latter are connected to a main collector by outlet pipes. The gas layer in the calandria tubes around the fuel channels insulates the moderator against fission heat. An important feature is a constriction in each fuel channel and the calandria tube which lies below the cooling water level in the pressurizing enclosure. Heat is withdrawn in a conventional heat exchanger which is part of the rest of the system described above. (F.S.A.)

## Marine and Portable Power Reactors

*Refer also to abstract 46918.*

**46978** (DOCKET-50238-45) N.S. SAVANNAH SAFETY ASSESSMENT. Summary Report of Volumes I Through V. Barrett, James M.; Carrico, Paul E. (Maritime Administration, Washington, D. C. Atomic Energy Commission, Washington, D. C.). Dec. 1962. 62p. (TID-17885). Dep. CFSTI.

A summary of the Safety Assessment for the N. S. Savannah is given. Summarized are the original volumes on: Engineering and Construction; Operations; Radiological Health; Analyses of Hypothetical Accidents; and Reactor System Tests and Sea Trials. (M.L.S.)

**46979** (DOCKET-50238-46) N.S. SAVANNAH SAFETY ASSESSMENT. VOLUME V. PART I. TEST AND SEA TRIAL REPORTS, SHIP TRIALS. (New York Shipbuilding Corp., Camden, N. J.). July 1962. 328p. (TID-17885(Vol.5)(Pt.1)). Dep. CFSTI.

Information on the Ship Trials for the N. S. Savannah is given under the following broad subjects: Hull; Machinery including reactor plant with associated systems, steam plant, and electrical plant; Trial Events and Reports; Machinery Name Plate Data; and Certificates and Documents. (M.L.S.)

**46980** (DOCKET-50238-47) N.S. SAVANNAH SAFETY ASSESSMENT. VOLUME V. PART II. TEST AND SEA TRIAL REPORTS, REACTOR SYSTEMS TESTS. (New York Shipbuilding Corp., Camden, N. J.). July 1962. 269p. (TID-17885(Vol.5)(Pt.2)). Dep. CFSTI.

Information on the testing of N. S. Savannah reactor systems is given under the following broad subjects: NSS-104 Summary Test Report — Phases I and II including reactor primary and auxiliary systems, instrumentation and control, electrical system, propulsion plant, and dummy run program; NSS-106 Summary Test Report — Reactor Operations at Camden; NSS-112 Summary Test Report — Reactor Operations at Yorktown; ORNL Shielding Survey; SML-NSS-1 Containment Vessel Leak Tests; ORNL-Iodine Removal Efficiencies of Reactor Compartment Ventilation Systems; NSS-116 Kinetics Stability Analysis; and SML-NSS-2 Reactor and Ship Operating Statistics. (M.L.S.)

**46981** (JPRS-46321) ATOMIC POWER PLANTS FOR SHIPS. Kanaev, A. A. Translated from pp 137-73 of Energetika Sudov Budushchego, Shipbuilding Publishing House, Leningrad, 1967. 32p. CFSTI.

Basic nuclear physics concepts are reviewed. The basic functioning of a reactor is described; its role in power production is summarized. Existing transport ships with nuclear power plants are discussed; elementary diagrams are shown. Types of reactors designed for ships are described; reactors for submarines and surface ships are discussed. (M.L.S.)

**46982** FDR ZERO POWER EXPERIMENT REACTOR OPERATION. Wrobel, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt, Geesthacht, Ger.). Atomkernenergie, 13: 315-18(1968). (In German).

For the FDR-0 experiments the staff of the critical facility (ANEX) was responsible for the described tasks, specially for the modification of ANEX and for the safe operation of the FDR (advanced pressurized reactor) of the research ship Otto Hahn according to safety report and license. (auth)

**46983** THERMAL NEUTRON FLUX DENSITY MEASUREMENTS WITH ACTIVATION DETECTORS IN THE FDR-O EXPERIMENT. Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 13: 334-9(1968). (In German).

The distribution of the thermal neutron flux is measured in horizontal and vertical directions with Au-foils and Dy-wires, which are detected with $\beta$-$\gamma$-coincidence technique resp. an automatic wire scanning apparatus. It is shown that the hottest channel and other hot channels are controlled by the incore instrumentation of the FDR. The macroscopic power distribution factor for the control rod position of the FDR with water temperature of 273°C is measured to 2.9 ± 0.2. The reactor power is evaluated by measuring the neutron flux distribution in the core with boric acid poisoned moderator water. (auth)

**46984** THE RESEARCH PROGRAMME AND THE MOST IMPORTANT RESULTS OF THE ZERO POWER EXPERIMENT WITH THE FDR CORE. Henning, K. (Gesellschaft fuer Kern-

energieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.); Kolb, M.; Ruppert, E.; Wiesner, S. Atomkernenergie, 13: 308-14(1968). (In German).

The results of the zero power experiment with the original core of the FDR for the nuclear research ship Otto Hahn show the theoretical design values for the core being in good agreement with the experiment. Therefore the operational data of the FDR are expected to be within the range of the lay-out conditions. In the reactor safety point of view the core loading procedure of FDR could be done knowing the physical parameters very well by this zero power experiment. (auth)

**46985** THEORETICAL DESIGN OF THE FDR CORE AND COMPARISON WITH EXPERIMENTAL RESULTS FROM THE ZERO-POWER EXPERIMENT. Henssen, H.; Memmert, G.; Rossbach, W. (INTERATOM, Bensberg, Ger.). Atomkernenergie, 13: 319-21(1968). (In German).

Special aspects of the core design are discussed in order to compare them with experimental results from the zero-power experiment. A number of nuclear calculations were tested by measurements in the zero-power experiment. Certain changes of the core configuration would have been possible to account for any essential discrepancies found. Evaluation of the experiments, however, showed satisfactory agreement for all decisive values. (auth)

**46986** PILE NOISE ANALYSIS IN THE DELAYED CRITICAL FDR-KERN. Robinson, E. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 13: 357-9(1968). (In German).

In the delayed critical core of the FDR, operated in the zero power range, pile noise analysis was done by means of digital counting rate measurements. By computing the autocorrelation function of the counting rates the decay constant of the prompt neutrons is determined. The average reactor power during counting rate measurements is calculated from the autocorrelation function and the measured average counting rate. The calculations presume the point reactor model to be applicable to the FDR in these experiments. (auth)

**46987** INCORE NEUTRON FLUX DENSITY MEASUREMENTS WITH SMALL SEMICONDUCTOR DETECTORS. Henning, K. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt, Geesthacht, Ger.); Ruppert, E.; Tauffenbach, H. J.; Wiesner, S. Atomkernenergie, 13: 322-6(1968). (In German).

Thermal neutron flux density distributions of the FDR-core have been measured during zero power experiments using an arrangement of 20 small semiconductor detectors, with the consequences of considerable gain of time compared to conventional activation detector technique. The results are well consistent with theoretical values. Some experimental difficulties as well as the calibration procedure are described. (auth)

**46988** EVALUATION OF THE FDR-O NEUTRON FLUX DENSITY MEASUREMENTS, COMPARISON OF EXPERIMENTAL AND THEORETICAL RESULTS. Mueller, E. (INTERATOM, Bensberg, Ger.). Atomkernenergie, 13: 327-33(1968).

The evaluation of the neutron flux measurements of the FDR zero power experiments is described, the calculation of a corresponding theoretical neutron flux distribution is outlined. The comparison of the experimental and theoretical distributions gives good agreement. This result well supports the nuclear and thermal design of the pressurized FDR light-water reactor for the nuclear ship Otto Hahn. (auth)

**46989** PULSED NEUTRON SOURCE REACTIVITY MEASUREMENTS IN THE FDR-O EXPERIMENT WITH AND WITHOUT BORIC ACID POISONING OF THE MODERATOR. Kolb, M.; Boettcher, G. Atomkernenergie, 13: 340-52(1968). (In German).

Reactivity measurements in the range ± 20 $ during the zero power tests of the FDR include the evaluation of pulsed neutron source measurements at large negative reactivities. By assuming l = const an equation is found for calculating the reactivity from the measured ratio of the prompt neutron decay constant in the critical and subcritical reactor which leads to more negative reactivities than the Simmons-King equation. The measurements gave a reactivity of −14.6 $ for the FDR-core with control rods inserted and of −2 $ with one outer control rod withdrawn. Excess reactivities were found by adding boric acid up to concentrations of 6 g $H_3BO_3$/l $H_2O$. The measured boric acid reactivity equivalent of 4.0 [$ $g^{-1}$] leads to a reactivity of 21.6 $ for the FDR-Core with all control rods withdrawn. The value of the burnable poison rods was found to be 9.2 $ by removing them from the experimental core quarter. (auth)

**46990** DIGITAL REACTIVITY MEASUREMENTS BY A ROD DRIVE METHOD. Schwieger, E. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomernenergie, 13: 353-6(1968). (In German).

The rod drive method described enables the calibration of control rods with high reactivity worth in short time. The rod to be calibrated is inserted stepwise into the critical reactor and the resulting negative reactivity is nearly compensated by withdrawing another rod after each step. The reactivity will be computed from the neutron density measured as function of time by solving the space-independent kinetic equations used in their differential form. This method was used to calibrate the control rods and rod-groups of the advanced pressurized-water reactor of the nuclear research ship Otto Hahn, during the zero-power experiments. By good choice of detector position, the results are found to be in good agreement with those obtained by the positive period method. (auth)

**46991** RADIATION FIELD INVESTIGATIONS WITHIN THE FDR SHIELD. Fiebig, R.; Frisius, F. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt, Geesthacht, Ger.). Atomkernenergie, 13: 361-6(1968). (In German).

In order to investigate the accuracies of shielding calculations at a full scale reactor shield, a program of measurements is carried out at the primary shield of the Otto Hahn reactor. Measurements in the shield regions inside and in the next vicinity of the pressure vessel are included. The preliminary results show that the multigroup removal-diffusion code RESTRAB gives nearly correct values for the total neutron flux. However the spectrum obtained in the fast energy region is too hard. The γ-dose rates given by this code are too high, because the sources of capture γ-rays in the shield are described rather incorrectly. A comparison of RESTRAB calculations with the design calculations of the Interatom shows that the RESTRAB neutron fluxes are higher by about a factor of 10. (auth)

**46992** STUDY OF THE ECONOMICALLY OPTIMAL DESIGN OF INTEGRATED PRESSURISED-WATER REACTORS FOR SHIP PROPULSION. Aass, H. L. (Technische Univ., Hanover). Kerntechnik, 10: 388-97(July 1968). (In German and English).

The independent core design parameters of an integrated pressurized-water reactor for ship propulsion are studied in the context of economic optimization of reactor design. After a brief description of the reactor and of the calculation methods used, the results obtained are plotted in graphs showing the influence and the optimum values of the design parameters. The results of the investigation are discussed and consequences are drawn. (auth)

**46993** MOBILE SHIP-BORNE NUCLEAR POWER. Marwick, Charles. New Sci., 39: 374(Aug. 22, 1968).

A new concept in portable power — a floating water-cooled nuclear reactor — has gone into operation. It will supply the extra electricity urgently needed to operate a series of locks in the Panama Canal. (auth)

**46994** DESIGN OF THE REACTOR FOR THE FIRST NUCLEAR-POWERED SHIP. Sato, Kagao (Japan Nuclear Ship Development Agency, Tokyo). Genshiryoku Kogyo, 14: No. 4, 13-29(Apr. 1968). (In Japanese).

The design at the present time of the reactor for the first nuclear-powered ship is described in detail. Some fundamentals underlying its design are: priority for its safety; use of the pressurized-water reactor; its "minimum" thermal output; and a fuel exchange once per two years. Features of the ship, including the reactor, are: the use as a freighter, as well as its trial nature; total tonnage 8,350 tons; navigation speed 16.5 kt; ship crew about 70; reactor thermal output 36 MW. (NSA of Japan)

**46995** INTEGRAL NUCLEAR REACTOR-HEAT EXCHANGER ARRANGEMENT. Deighton, Thomas (to Babcock and Wilcox, Ltd.). U. S. Patent 3,397,114. Aug. 13, 1968. Filed July 5, 1966.

An integral nuclear reactor for marine service is described comprising an upright closed pressure vessel having a substantially cylindrically shaped body portion and removable end portion. The vessel, which houses the reactor core and heat exchanger, is adapted to have a primary coolant circulated through the core. Heat generated by the core is transferred to secondary coolant passing through the heat exchanger. The secondary coolant passes from outside the vessel into the heat exchanger via a ring header coaxially disposed intermediate the end and body portions. The ring has a stepped cross-section to accommodate lateral thrust problematic to marine reactors. Conduits passing through openings formed radially of the ring conduct secondary coolant into the reactor vessel for flow through the heat exchanger and out of the vessel after flowing through the exchanger. (Offic. Gaz.)

**46996** PRELIMINARY EXPERIMENTS FOR AN EXPERIMENTAL ARRANGEMENT OF THE SECOND CORE OF THE FDR. Froehner, K. R.; Krull, W.; Richter, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 13: 367-70(1968). (In German).

Second core loading of Otto Hahn's reactor FDR will consist of square shaped fuel elements only, omitting the four triangle shaped elements. This space may partially be used for instrumentation and also for experiments during reactor operation, e.g., corrosion tests and compatibility tests on material combinations. As a first step, thermal neutron flux distribution was measured by foil activation in three different configurations of the core corner; the measurements were part of the FDR-0 experiment schedule. (auth)

**46997** THE LOW POWER EXPERIMENT IN GEESTHACHT FOR THE NS OTTO HAHN REACTOR CORE. Bagge, E.; Fischer, E.; Wiebe, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie, 13: 306-7(1968). (In German).

After discussing the motives for conducting a zero-power experiment with the core of the "Otto Hahn" reactor attention is called to the most important stipulations contingent to the planning and preparation of these tests in the Geesthacht critical facility with respect to scientific-technical and organisatory aspects. (auth)

## Rocket and Space Reactors

*Refer also to abstract 46918.*

**46998** (N-68-23894) REACTIVITY INSERTIONS IN COMPACT REACTOR CORES DUE TO FUEL MOVEMENT. Sullivan, Robert E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1968. 14p. (NASA-TM-X-1587). CFSTI.

The reactivity effect of fuel movement in several compact reactor cores, highly fueled with $^{233}UO_2$ is calculated using a computer program to solve the Boltzmann transport equation. (auth)

**46999** (N-68-24559) REACTIVITY CONTROL OF FAST-SPECTRUM REACTORS BY REVERSIBLE HYDRIDING OF YTTRIUM ZONES. Anderson, John L.; Mayo, Wendell; Lantz, Edward (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1968. 35p. (NASA-TN-D-4615). CFSTI.

The temperature dependent equilibrium hydrogen content of yttrium hydride above 1173°K is investigated as a means of reactivity control for a cylindrical reactor using zones of hydride in various in core and reflector configurations. The temperature dependence is such that the control system is inherently self-regulating. Severe power peaking, dependent on the hydrogen density, occurs at the hydride core interfaces. Use of auxiliary control for startup reduces the control demand on the variable hydriding system and thus reduces the power peaking. A configuration for which the reactivity control satisfies required core life and power peaking limits is presented. (auth)

**47000** (ORNL-TM-2086) COMPARISON OF BOILER FEED PUMPS FOR CESIUM AND POTASSIUM RANKINE CYCLE SYSTEMS. Young, H. C.; Clark, D. L.; Grindell, A. G. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 73p. Dep. CFSTI.

A study was made of the electromagnetic pump and the electric motor driven (canned rotor) and free turbine driven centrifugal pumps for the boiler feed duty in Rankine cycle systems having an output of 300 kW(e) with cesium or potassium as the working fluid. The polyphase helical induction pump was chosen to represent the electromagnetic pumps. The weight of the basic pump and the increase in weight of the Rankine cycle system (weight penalty) required to supply pump power and control requirements were estimated for each pump. A discussion is presented of some of the unique problems and design considerations associated with each pump such as start-up, control, bearing materials, and auxiliary equipment. Design precepts and preliminary design data for each of the pumps are presented. 36 references. (auth)

**47001** NUCLEAR ENERGY SUPPLY FOR SPACE VEHICLES WITH LIQUID METAL MHD CONVERTER AS ANALOG TO SNAP-8 AND SNAP-50. Radebold, R. Nachrichtentech. Fachber., 32: 119-22(1967). (In German).

A thermionic converter in which a liquid metal is used as the working medium in place of electron gases is described. The usual thermionic system has a very high working temperature of the order of magnitude of 1700 to 1800°C. The construction of the converter ensemble is simple in principle. A single cell yields a direct voltage of the order of one volt. The method described, with a magnetohydrodynamic converter and a liquid metal as working medium, works at much lower temperatures of the order of magnitude of 850 to 950°C at approximately the same total efficiency. The construction of the ensemble is complicated since it also contains no mechanically moving parts. The ensemble produces electrical power at voltages up to several kV with frequencies up to 400 Hz. (J.S.R.)

## Process Heat and Desalination Reactors

*Refer also to abstracts 45218 and 46918.*

**47002** (ORNL-TM-2202) PRODUCTION OF AMMONIUM NITRATE FERTILIZER BY USING LOW-COST ENERGY FROM A NUCLEAR DESALINATION REACTOR. Holmes, J. M.; Salmon, R.; Blanco, R. E.; Ullmann, J. W. (Oak Ridge National Lab., Tenn.). Apr. 30, 1968. 20p. Dep. CFSTI.

The cost of producing $NH_4NO_3$ using low-cost power from a nuclear desalination reactor was estimated and compared with that for the conventional steam-methane process. $H_2$ was produced by the electrolysis of water using advanced-type cells now under development and ac power costs varying from 1.0 to 3.0 mills/kWhr. $HNO_3$, $NH_3$, and $NH_4NO_3$ were produced with the $H_2$ by conventional methods. The capital cost of the $HNO_3$ plant was reduced by about 8% by using $O_2$ from the electrolysis plant instead of air. $N_2$ for the $NH_3$ plant was recovered from the $HNO_3$ tail gas. The results showed that $NH_4NO_3$ produced in a 698-ton/day plant using low-cost nuclear power at 1.6 mills/kWhr could compete with the product from a conventional reforming plant using 31¢/$10^6$ Btu natural gas. If $O_2$ credit is allowed ($4/ton $O_2$ for 10 and 15% return on investment and $2/ton $O_2$ for 4% return on investment), electrolysis would compete with plants using 20¢/$10^6$ Btu natural gas. At larger plant sizes, the comparison is less favorable to the electrolytic process, because of its poorer scaling factor. At 2330 tons/day of $NH_4NO_3$, 1.6 mills/kWhr electricity competes with 34.5¢ natural gas, assuming no $O_2$ credit. The average U. S. industrial natural gas price in 1963 was about 34¢/$10^6$ Btu. 31 references. (auth)

## Research and Test Reactors and Critical Assemblies

*Refer also to abstracts 45304, 46809, 46918, and 46920.*

**47003** (AI-CE-75) HEAVY WATER ORGANIC COOLED REACTOR. FUEL IRRADIATION EXPERIMENT EXP-NRU-305 ALTERNATE I. Falk, E. D.; Forrester, R. E.; Wolfe, W. B.; Sullivan, R. J. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. [Nuclear Div.]). June 15, 1968. Contract AT(38-1)-430. 73p. Dep. CFSTI.

The 305-U Al experiment was the second in the 305-U series of fueled irradiations in support of the HWOCR program. The irradiation was conducted in the organic cooled U-3 loop in the AECL-owned NRU reactor at Chalk River, Ontario. The fuel string consisted of three SAP-clad UC bundles and two Zircaloy-4-clad $UO_2$ bundles. The fuel string operated very satisfactorily for 17 months at design conditions of 20.8 kw/ft peak power rating, 326,000 Btu/hr-ft$^2$ peak cladding heat flux, and reached a record burnup on the SAP-UC fuel of 16,700 Mwd/MTU (peak) and a peak burnup of 14,000 Mwd/MTU on the Zr-$UO_2$ fuel. Two promising organic coolants, Santowax OM and HB-40, were tested. Both coolants performed well as heat transfer media with coolant outlet temperatures ranging from 653°F (345°C) to 752°F (400°C) and high boiler contents ranging up to 30 wt %. Surface film formation was studied and found to be dependent on the water concentration in the coolant. This experiment showed that coolant impurity levels can be much higher than levels previously considered acceptable in organic cooled systems. Although the normal indices of coolant purity were allowed to rise to levels heretofore thought unacceptable, the fuel continued to operate satisfactorily without fouling. 11 references. (auth)

**47004** (APDA-216(Vol.1)) ANALYSIS OF SODIUM REACTIVITY MEASUREMENTS. VOLUME I. CROSS SECTION EVALUATION AND DATA TESTING. Pitterle, T. A.; Page, E. M.; Yamamoto, M. (Atomic Power Development Associates, Inc.,

Detroit, Mich.). June 1968. Contract AT(11-1)-865. 104p. Dep. CFSTI.

An analysis of sodium reactivity measurements in fast reactor critical assemblies is presented. Volume II presents the sodium-void analysis. In Vol. I, emphasis is placed on cross section evaluation and data testing conducted to establish the accuracy of the cross section data used for the calculations of Vol. II. Volume I describes the evaluation of the cross section data, testing of the data by comparison of calculations with integral experiment measurements, and an examination of methods used for critical assembly calculations. Neutron cross sections important for the sodium analysis have been evaluated as modifications to the ENDF/B data file. Calculations of criticality, reaction-rate ratios, and material worths using both the ENDF/B and modified ENDF/B data have been made for ZPR-III Assemblies 48, 48B, 49, and ZPR-VI Assemblies 2 and 3. The modified ENDF/B data are found to be over-reactive for these assemblies by 0.2% to 0.4% $\Delta k$ while the ENDF/B data are under-reactive by 1.3% and 0.7% for the $^{239}Pu$ and $^{235}U$-fueled assemblies, respectively. In general, the modified data yield better agreement with experiment than the ENDF/B data. Methods examined include resonance self-shielding techniques, variations in number of groups and geometrical representation, an investigation of absolute central worth discrepancies, and the use of cell-homogenized cross sections. The cell-homogenized cross sections are obtained as averages over transport-theory calculations of the spatial distributions of the flux in the plates forming a cell. These calculations indicate that the plate heterogeneities may have significant effects on the real and adjoint flux spectra. (auth)

**47005** (APDA-216(Vol.2)) ANALYSIS OF SODIUM REACTIVITY MEASUREMENTS. VOLUME II. SODIUM VOID CALCULATIONS. Pitterle, T. A.; Page, E. M.; Yamamoto, M. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1968. Contract AT(11-1)-865. 104p. Dep. CFSTI.

The second of a two-volume report on an analysis of sodium reactivity measurements in fast reactor critical assemblies is presented. Volume I describes the cross section evaluation and data testing conducted in support of the sodium void analyses. Volume II describes the methods of calculation and the calculated results for an analysis of sodium void measurements performed in ZPR-III Assemblies 48 and 48B and ZPR-VI Assemblies 2 and 3. The detailed void measurements in the assemblies have been calculated using the MENDF/B cross section data described in Volume I, and additional calculations have been with the ENDF/B data. The basic method of calculation is perturbation theory in one- and two-dimensional diffusion theory. Methods examined include variations in resonance self-shielding techniques, number of groups, variations of perturbation theory including exact perturbation theory, transport theory, and heterogeneity considerations. For the heterogeneity analysis, cell-homogenized cross sections are obtained by flux-weighting over the cell using transport theory calculations of the spatial flux distributions. Overall calculations of the void reactivities with the MENDF/B data show better agreement with experiment, particularly for the $^{239}Pu$-fueled assemblies. For centrally voided regions, the MENDF/B data yield the following qualitative agreement with experiment: 25% less positive than experiment for Assemblies 48 and 48B, 15% less negative than experiment for Assembly 2, and 25% more negative than experiment for Assembly 3. Regions with large leakage contributions tend to be consistently underestimated by about 15% with maximum discrepancies of 25% for all assemblies analyzed. Heterogeneity and transport theory effects on the void reactivities are found to be notably large for Assembly 48. (auth)

**47006** (BNWL-748) A CONSIDERATION OF HIGH-NICKEL CONTENT ALLOYS FOR FTR CORE STRUCTURAL MATERIALS. Johnson, R. N.; Kovacevich, E. A.; Moen, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 40p. Dep. CFSTI.

Physical and mechanical properties for selected materials to be used in fabricating FTR core components are presented. The materials tested include Type 304 stainless steel, Type 316 stainless steel, Incoloy 800, Inconel 600, Nickel 200, Inconel X-750, Inconel 718, Satellite 1016, and Stellite 6B. Thermal stability, irradiation effects, fabricability, weldability, and costs are considered in deriving the optimum materials. (D.C.C.)

**47007** (BNWL-812) DESIGN AND FABRICATION OF A SODIUM PURIFICATION LOOP. Kelly, V. P.; Owen, T. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 40p. Dep. CFSTI.

The purpose of the Sodium Purification Loop is to prepare Na of known and controlled purity to supply characterized Na for analytical methods calibration, for loading test capsules and loops, and for tests of Na samplers and chemistry instruments in the Fast Flux Test Facility coolant chemistry studies. The design and fabrication of the forced-convection loop rated for nominal flow of 2 gpm and equipped with both a cold trap and a hot trap are reported. (H.D.R.)

**47008** (GA-8715) FAST REACTOR SPECTRUM MEASUREMENTS. Annual Progress Report for the Period Ending April 30, 1968. Preskitt, C. A.; Neill, J. M.; Young, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). June 3, 1968. Contract AT(04-3)-167. 48p. Dep. CFSTI.

A description of the STSF split-table assembly is presented. The first core loading for the assembly, designated STSF-1, is described. Description of the experimental electronics is presented. Data reduction procedures are analyzed. Spectra measurements for intermediate and fast neutrons are presented. (D.C.C.)

**47009** (GEMP-627) TECHNICAL OPERATING LIMITS FOR THE FLEXIBLE SPLIT TABLE CRITICAL EXPERIMENT ASSEMBLY AT THE LOW POWER TEST FACILITY. (General Electric Co., Idaho Falls, Idaho). July 23, 1968. 8p. Dep. CFSTI.

The technical operating limits are presented for the operation of the Flexible, Split-Table Critical Assembly at the Low Power Test Facility. This assembly is the same as that used for the 710 Critical Experiment Reactor. (auth)

**47010** (GEMP-629) CAVITY REACTOR CRITICAL EXPERIMENT. Progress Report for the Period Inception Through July 31, 1968. (General Electric Co., Idaho Falls, Idaho). Aug. 8, 1968. 18p. Dep. CFSTI.

A description of the critical core configuration is presented. Power maps from bare catche foils are presented. The alterations for wave experiments are described. Power and flux maps for the altered configuration are presented. (D.C.C.)

**47011** (IFA-FR-65) APPROXIMATION OF FAST NEUTRON SPECTRUM OF REACTOR BY MEANS OF DIFFERENT MATHEMATICAL METHODS USING THRESHOLD DETECTOR DATA. Grancea, I.; Cuculeanu, V. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 16p. Dep.

Methods for determining the fast spectrum of the WWR-S research reactor are considered. For analysis of threshold detector data, the orthonormal function and orthonormal polynomial methods are described. The results of Legendre and Chebyshev calculations are compared. (M.L.S.)

**47012** (INR-895) SPECTRUM INDEX Lu: Dy MEASUREMENTS IN WWR-SM CRITICAL ASSEMBLY CORES. Jozefowicz, Edward T. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 11p. Dep.

The spectrum index Lu: Dy is measured in selected WWR-SM cores at some points in "normal" cells and is compared with the results of S-II-THERMOS Code calculations. The measurements are also performed near the control rod, water channel and reflector and in the water trap. (auth)

**47013** (K-L-6214) SOLID ANGLE METHOD OF SPACING. Newlon, C. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 8, 1968. Contract W-7405-eng-26. 5p. (CONF-680909-2). Dep. CFSTI.

From Symposium on Neutron Interaction in Arrays of Fissionable Materials, Livermore, Calif.

The solid angle method for assembling safe arrays of fissile material is formulated. The spacing criteria specify that an array unit should be: (a) individually safe for the system moderator and reflector, and (b) separated on the basis of an allowable solid angle or at a safe isolation distance for the separation medium. A safe interaction curve for units with specified multiplication factors is presented. (H.D.R.)

**47014** (LA-DC-9840) DENSITY-ANALOG TECHNIQUES. Paxton, H. C. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 10p. (CONF-680909-1). Dep. CFSTI.

From Symposium on Neutron Interaction in Arrays of Fissionable Materials, Livermore, Calif.

The density-analog scheme to provide criticality information about arrays of fissile material is examined. The original scheme was based on the hypothesis that critical cubic arrays behave like homogeneous systems when the average density of fissile material is changed by spacing variation. A useful rule-of-thumb relation for judging if a storage array is conservatively subcritical is formulated, and two improved approximations derived from the original formulation are examined. (H.D.R.)

**47015** (N-68-24522) DETERMINATION OF NEUTRON SPECTRA IN A COUPLED GRAPHITE-HEAVY WATER REACTOR. Casali, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated from report RT/FI-(66)38. 14p. (NASA-TT-F-11706). CFSTI.

Two-group theory analysis of the effect on k of indeterminateness of the spectrum in the reactor RB1 under certain conditions is presented. When charged with 7 to 13 fuel elements and used under the specified conditions the reactor RB1 exhibits the characteristics of an infinite reactor and the spectrum is of no great importance, but efforts should be made to produce or obtain suitable structural materials to delimit the zone under examination. (auth)

**47016** (ORNL-4169(Vol.1)) THE OAK RIDGE RESEARCH REACTOR: A FUNCTIONAL DESCRIPTION. Hamrick, T. P.; Swanks, J. H. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 261p. Dep. CFSTI.

ORNL RESEARCH REACTOR—description of, summary; cooling system for, layout diagrams for; cooling tower for, block diagram of fan system for; control systems for, safety analysis of; site for, safety analysis of; reactor building for, summary description of; containment systems for, safety analysis of; test holes for, summary description of; fuel elements for, nominal design parameters for; pressure vessel penetrations for, tabular summary of; cooling system for, safety analysis of; radioactive waste handling at, safety analysis of; core for, nuclear and heat transfer characteristics of; electrical systems for, safety analysis of; auxiliary and emergency systems for, safety analysis of

BIBLIOGRAPHIES—on ORNL Research Reactor (M.L.S.)

**47017** (ORNL-TM-2243) HIGH FLUX ISOTOPE REACTOR. Quarterly Report, October-December 1967. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). May 21, 1968. Contract W-7405-eng-26. 132p. Dep. CFSTI.

ORNL HIGH FLUX ISOTOPE REACTOR—operation history for; control system for, operations performance of; cooling systems for, summary of maintenance of; control plates for results of testing of; control plates for, analysis of problems with; control plate for, results of strain gage tests under cold flow conditions of; control plates for, radiation effects on tensile properties of; control plate drives for, drag effects on scram travel and time of flight

REACTOR CONTROL SYSTEMS—performance of HFIR

REACTOR CONTROL ELEMENTS—stresses on HFIR, effects of rod position on static load induced; tensile properties of HFIR plate-type, radiation effects on; bearing lugs for HFIR plate-type, results of high-load low-cycle fatigue tests on; drives for, drag effects on scram travel and time of flight. (M.L.S.)

**47018** (ORNL-TM-2296) BULK SHIELDING FACILITY QUARTERLY REPORT, JANUARY-MARCH OF 1968. Tabor, W. H. (comp.) (Oak Ridge National Lab., Tenn.). July 1, 1968. Contract W-7405-eng-26. 33p. Dep. CFSTI.

The Bulk Shielding Reactor operations, maintenance, and components and systems performance are summarized. An experiment performed in the Pool Critical Assembly is described, and maintenance on instrumentation and mechanical features is reported. (H.D.R.)

**47019** (PEL-152) THE TIME DEPENDENCE OF THE NEUTRON FLUX AND TEMPERATURE OF A THERMAL MULTIPLYING SYSTEM FOLLOWING A STEP CHANGE IN REACTIVITY. van der Walt, R.; Moehr, J. G. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1967. 34p. Dep.

A FORTRAN IV programme for an IBM System/360 Model 40 Computer, with 128 K bytes of storage, has been developed to study accident conditions in critical and subcritical thermal multiplying systems. The programme computes the time behaviour of the thermal neutron density and the system temperature following a step change in reactivity. The integrated thermal neutron density is also computed, from which the total number of fissions during an excursion may be obtained. (auth)

**47020** SELF-CHECKING REACTOR SAFETY AND INTERLOCK SYSTEM. Zobor, E.; Bollok, L. (Central Research Inst. for Physics, Budapest). Atomkernenergie, 13: 377-80(1968).

A safety interlock system is described that has been developed and built at the Laboratory for Reactor Physics and Technics of the Central Research Institute for Physics, Budapest and is in several respects different from the self-checking systems. The reactor protected by the system is of solid homogeneous type with a core of 20% enriched uranium oxide dispersed in polyethylene. To meet possibly all safety requirements and to gain experience about the possibilities offered by semiconductor logic elements in reactor control, a self-checking safety interlock system was developed, using commercially available EDS 4000 [Statomat] logic elements manufactured by EMG, Budapest and some special circuits designed at the laboratory. (auth)

**47021** STUDIES ON CRITICALITY CONDITIONS FOR ALUMINUM OXIDE -MODERATED HOMOGENEOUS MULTIPLICATION SYSTEMS. Lo Surdo, C.; Bisi, F. pp 305-18 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

Criticality calculations for fast reactor systems are described. Core density is shown as a function of radius and buckling. Results of calculations for a bare system are shown. Calculations of effects of reflectors of C, BeO, and $Al_2O_3$ are shown as a function of reflector thickness. 12 references. (M.L.S.)

**47022** MULTIREGION FAST REACTOR EXPERIMENTS. Carpenter, S. G.; Mountford, L. A.; Springer, T. H.; Strominger, D.; Tuttle, R. J. pp 91-109 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A description of an Al-$^{235}$U-fueled critical assembly is presented. The critical assembly uses reduced-density Al for Na and graphite and Be for moderators. Calculations for the kinetic properties of the nine critical assemblies are presented. (auth)

**47023** SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Cohen, K.; Greebler, P.; Horst, K.; Wolfe, B. pp 343-64 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The Southwest Experimental Fast Oxide Reactor (SEFOR) is designed to be fueled with mixed $PuO_2$-$^{238}UO_2$. The reactor will be used to obtain precise physics and engineering data at fuel compositions, temperatures, and crystalline states characteristic of power reactor operating conditions. SEFOR is particularly designed for the systematic determination of the Doppler coefficient of reactivity at temperatures up to fuel melting. Characteristics of the SEFOR reactor are presented. 8 references. (auth)

**47024** THE FAST CRITICAL ZERO ENERGY ASSEMBLY KARLSRUHE: SNEAK-AND ITS EXPERIMENTAL PROGRAMME. Stegemann, D. (Kernforschungszentrum, Karlsruhe, W. Ger.). pp 365-75 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The design characteristics of the SNEAK critical assembly are presented. The experimental program for SNEAK is described. (D.C.C.)

**47025** EXPERIMENTAL BALANCE FOR QUALITY ASSURANCE FOR RAPSODIE. Delisle, J. P.; Droulez, M.; Gollion, H. J.; Lions, N.; Sauvage, M.; Vautrey, L. pp 419-56 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A description of the heat transfer systems of Rapsodie is given; thermal-hydraulic characteristics are tabulated for 1 MW and 10 MW power levels. Requirements for reactor core and systems are listed; integrity of containment systems is discussed. The preheating system is described. The coolant circulating systems are discussed; schematics of the primary Ar system and test loops are shown. Design characteristics for the heat exchangers are tabulated. The Na purification system is described. 3 references. (M.L.S.)

**47026** THERMAL NEUTRON FLUX DISTRIBUTION IN VARIOUS REFLECTORS WITH CHANNELS. Sarychev, M. A.; Aleksenko, Yu. N.; Zvonov, N. V.; Buinitskaya, V. I.; Rogozhkin, I. B.; Batalov, A. A.; Aleksandrov, Yu. V. At. Energ. (USSR), 24: 467-9(May 1968). (In Russian).

Thermal neutron flux measurements at the exit portal of a reactor test hole are described. Effects of reflector configuration on thermal neutron flux profiles are considered. Ratios of $^{1}H/^{235}U$ are given for the reactor core. Results of the measurements are discussed; data are tabulated. (R.V.J.)

**47027** MEASUREMENT OF DYNAMIC REACTOR PARAMETERS BY PHOTON OBSERVATION. Lehto, Wayne Kutramo.

Ann Arbor, Mich., Univ. of Michigan, 1967. 115p.
Thesis.

Fission rate fluctuations at low power in a reactor with a large fission product inventory have been observed in the pool-type Ford Nuclear Reactor. A gaseous Cherenkov detector was used to sense the high energy prompt fission gamma rays in the presence of a fission product gamma field of $10^5$ to $10^6$ R/hr. The ratio $\beta/l$ is determined from the cross power spectral density of the fluctuations in the signals from two of these detectors. Both this spectrum and the power spectral density in the output of a single detector show a large low frequency component. This is attributed to moderator temperature fluctuations present when the fission product decay heat is removed by natural circulation of the coolant. The temperature fluctuations as measured with a short time constant thermocouple are shown to be correlated to those in the fission rate. A basis for calculating the performance of the detector is developed and a theory of the experiment is presented. Results of tests to prove the operating principles of the detector and to investigate its response to changes in reactor power level are reported. The detector is described and improvements to the present model are outlined with suggestions for desirable future experiments. (Disser. Abstr.)

**47028** MIXED FIELD DOSIMETRY IN A NEUTRON EXPOSURE VOLUME OF A MODIFIED RESEARCH REACTOR. Simpson, R. E.; Hightower, D.; Jones, E. O. (Walter Reed Army Medical Center, Washington, D. C.). Health Phys., 15: 269-74(Sept. 1968).

In some radiobiological experiments on mice, graphite was removed from the horizontal thermal column of the WRRR, so that a large number of mice could be exposed simultaneously to a high flux of fission neutrons, and because of the reactor modifications it was necessary to characterize the energy spectrum of the neutron beam and to evaluate the neutron and gamma dose contributions of the mixed radiation field. The uniformity of the field and the beam intensity at the exposure position had also to be determined; this was done for the "free-in-air" condition and for phantoms of mice of unit density placed within the graphite mouse tubes. The support dosimetry associated with the experiments is described. Total dose (n + γ) was obtained using modified Sievert type miniature condenser ionization chambers constructed of type A tissue-equivalent conducting plastic. The gamma dose was measured with "neutron insensitive" $^7$LiF thermoluminescence dosimeters, and the neutron energy spectrum and fast neutron dose were evaluated by a threshold detector system. Results are tabulated and discussed. (UK)

**47029** ON THE PRODUCTION OF FUELS FOR THE FCA. Hoshino, Koji (Furukawa Electric Co., Ltd., Japan). FAPIG (Tokyo), No. 48, 240-7(Feb. 1968). (In Japanese).

The FCA (Fast Critical Assembly) went critical in April 1967. With the critical assembly, a variety of experiments are performed by either changing its core structure, or increasing the core size itself. The fuel etc. regions contain the following: metallic uranium blocks used as the blanket, natural uranium plates for diluting the core, and 20% enriched uranium plates. A description is made of the natural uranium blocks and natural uranium plates, and also of enriched uranium plates to be produced in the future. (NSA of Japan)

**47030** ON THE HEAT-LOAD TEST OF THE COOLING TOWERS IN THE UTILITIES COOLING LINE OF JMTR. Hayashi, Shigeru; Obata, Kiyokazu (Kawasaki Dockyard Co., Ltd., Japan). FAPIG (Tokyo), No. 48, 262-5(Feb. 1968). (In Japanese).

Actual and non-actual heat-load tests were performed on the cooling towers in the utilities cooling line of JMTR. The results of the tests are described. The utilities cooling line serves in-pile loops, out-of-pile irradiation and flow test facilities, (air conditioning of) the JMTR housing, diesel dynamos, and control-rod drives; and, some features of the line are heat removal 10 MW, cooling-water flow 860 $m^3$/hr., cooling-water 42°C (tower inlet) and 32°C (tower outlet), outer wet-bulb temp. 26.5°C. (NSA of Japan)

**47031** FAST-NEUTRON IRRADIATIONS IN THE REACTOR CORE, AND THEIR APPLICATIONS. Shigeta, Mitio; Arima, Shoichi (Tokyo Atomic Energy Industrial Research Lab., Ltd.). Genshiryoku Kogyo, 14: No. 4, 41-6(Apr. 1968). (In Japanese).

The HTR is a swimming-pool type reactor with heat output 100 kW(t) fueled with enriched uranium. The results of experiments with the HTR are described in the following: the construction of HTR; neutron fluxes in the HTR core; irradiations in the core; nuclear reactions with the fast neutrons for (n,p), (n,α), (n,2n), and secondary nuclear reactions; applications of the fast neutrons for production of carrier-free radioisotopes, activation analyses, and tracer uses. (NSA of Japan)

**47032** USES OF THE JMTR. Hirayama, Shoichi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 14: No. 4, 33-40(Apr. 1968). (In Japanese).

The JMTR (Japan Material Test Reactor) of JAERI is going into criticality March 1968. It is solely for the purpose of testing materials. The JMTR of heat output 50 MW, with experimental-hole neutron fluxes: fast $1 \times 10^{14}$ (fuel region) and $0.5 \times 10^{14}$ (max. reflector region) and thermal $3 \times 10^{14}$ and $2 \times 10^{14}$ (correspondingly) n/$cm^2$·sec., is described in the following: basic principles behind the joint use of JMTR; an outline of JMTR; its operational program; the charges for irradiations and tests. (NSA of Japan)

**47033** METHOD FOR CONTROLLING THE TEMPERATURE OF A SAMPLE MATERIAL IRRADIATED IN A REACTOR. Miyao, Jiro (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-4915. Feb. 22, 1968. Filed Sept. 5, 1963.

A sample material is irradiated in its container in a reactor. This container is double-walled, and the space produced between the two walls is filled with different heat-insulating gases by a means outside the reactor. An electric heater is installed within the container. In addition to the replacement of one insulating gas by another, the mixing ratio of different heat-insulating gases can also be changed. (NSA of Japan)

**47034** DEVICE FOR HANDLING AN IRRADIATED SAMPLE. Shibayama, Tetsuo (to Mitsubishi Atomic Power Industry, Inc.). Japanese Patent 1968-10479. May 1, 1968. Filed Nov. 18, 1965.

The rabbit system described includes: a sample-holder path running from the outside to the reactor core with a sample-capsule dropping path connected to it outside the reactor; a long rod running through the (horizontal) path with threads cut on the outside for moving the sample holder back and forth; and, two separate pieces of the sample holder, each of which engages with the threads of the rod so that it moves back and forth along the rod when the rod is rotated. The pitch between the threads on the rod is made wider where the "dropping" path is located. Thus, when the two pieces of the holder with a sample reach the "dropping" area along the rod, the two are separated farther away, thereby dropping the sample capsule into the dropping path. (NSA of Japan)

**47035** DEVICE FOR CHANGING THE PATHS. Motomiya, Kimio (to Hitachi Ltd.). Japanese Patent 1968-4916. Feb. 22, 1968. Filed Jan. 29, 1965.

The device proposed is for connecting the path of a pneumatic tube from the reactor core to any of the several branch paths outside the reactor; the mechanism of connection is done automatically. The pneumatic tube from the reactor core is connected to a hole through the end plate of the cylindrical body, and multiple branch tubes connect to the corresponding holes through the other end-plate. Within the cylindrical body, a curved connecting pneumatic-tube is installed, and by rotating it with a gear system, the desired connection is achieved; the horizontal movement of the connecting tube, which is necessary, is made while the rotation is suspended. Sealing packings are provided at the connections. (NSA of Japan)

**47036** FACILITY FOR THE HYDRAULIC TRANSFER OF IRRADIATION CONTAINERS. Mitault, G.; Puychevrier, J. (to Commissariat a l'Energie Atomique). Canadian Patent 785,879. May 21, 1968. Priority date June 20, 1963, France.

A charge and discharge station for irradiation containers is located outside the tank of a swimming pool reactor. The design of an installation is described which avoids the passage of activated water into that portion of the circulating system located outside the reactor tank while transfer operations are in progress. A pump and isolating valves causes the water to circulate either in one direction or the other within a circulating tube and a compensating reservoir tank. A transit tube is supplied with purified water so that no activated water reaches the exterior charge-discharge station. The core cooling system is employed to produce a suction of water for the removal of heat dissipated by the irradiation container. (F.S.A.)

**47037** A FACILITY FOR THE STUDY OF NEUTRON MODERATION AT CRYOGENIC TEMPERATURES IN A LIGHT WATER POOL NUCLEAR REACTOR. Antal, J. J.; Landry, A. F.; Warnas, A. A. (Army Materials and Mechanics Research Center, Watertown, Mass.). Advan. Cryog. Eng., 13: 715-27 (1967).

From Cryogenic Engineering Conference, Palo Alto, Calif. See CONF-670801-(Vol.2).

Holding a small amount of moderator material at very low temperatures in a nuclear reactor provides a very useful source for the production of high-intensity low-energy neutron beams, which are employed in studies concerning solid and liquid structural state of materials. Since very little is known of the factors af-

fecting the efficiency of such sources, an experimental facility has been placed in operation to study various parameters, particularly the spatial distribution of the cold moderator. The facility and its design and operation are described, with emphasis on problems created by the addition of a nuclear radiation field to the cryogenic environment. The results of initial studies on the moderation of neutrons by solid methane at 84°K are presented. (auth)

## Production Reactors

*Refer also to abstract 46918.*

## Reactor Theory, Components, Fuels and Accessories

*Refer also to abstracts 45328, 45347, 45348, 45761, 45752, 45806, 45808, 45810–45812, 45831, 46696, 46700, and 46703.*

**47038** (AECL–3106) IN REACTOR PERFORMANCE OF DEFECTED ZIRCALOY-CLAD $U_3Si$ FUEL ELEMENTS IN PRESSURIZED AND BOILING WATER COOLANTS. Feraday, M. A.; Allison, G. M.; Ambler, J. F. R.; Chalder, G. H.; Lipsett, J. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1968. 36p. (EXP-NRX–61607). Dep. CFSTI. CAN $1.00.

The results of two in-reactor defect tests of Zircaloy-clad $U_3Si$ are reported. In the first test, a previously irradiated element (5300 MWd/tonne U) was defected then exposed to first pressurized water then boiling water at 270°C. In the second test, an unirradiated element containing a central void was defected, waterlogged, then exposed to pressurized water for 50 minutes. Both tests were terminated because of high activity in the loop coolant detected by both $\gamma$ and delayed neutron monitors. Post-irradiation examination showed that both elements had suffered major sheath failures which were attributed to the volume increase accompanying the formation of large quantities of corrosion product formed by the reaction of water with the hot central part of the fuel. It was concluded that the corrosion resistance of $U_3Si$ at 300°C is not seriously affected by irradiation, but the corrosion rate increases rapidly with temperature. (auth)

**47039** (ANL–7332) THE ARGONNE REACTOR COMPUTATION (ARC) SYSTEM. Toppel, B. J. (ed.) (Argonne National Lab., Ill.). Nov. 1967. Contract W-31-109-eng-38. 349p. Dep. CFSTI.

The purpose and basic concepts of the ARC system to facilitate reactor physics calculations that involve many independent computations are presented. The system is being implemented on an IBM 360 Model 50-75 computer complex, and has two major advantages over conventional computer codes. These are: (1) The ability to automate the linkage of computational modules without human data handling. (2) The ability to store and later retrieve data generated by an ARC run to facilitate the rerunning of previous problems with data changes or to extend previous problems into further computational areas. The system consists of: (1) The Datapool for collection of data and computational algorithms that can be used by ARC. (2) Computational Modules which are conventional program subroutines. (3) Standard Paths which are control programs similar to the driver portions of large conventional codes. (4) Operating System for collection of codes which form the interface between ARC and the computer hardware. The system structure and modules are described and a data module glossary is presented. (H.D.R.)

**47040** (APDA–228) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, APRIL–JUNE 1968. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 78p. Dep. CFSTI.

CROLOY — wastage rate during water leaks in sodium systems, effects of sodium temperature and circulation on, (E)
LEAK DETECTORS — use of acoustic, for steam leakage into sodium systems, (E)
STEAM — leakage into sodium systems, acoustic detection of, (E)
SODIUM — reactions with water, acoustic detection of, (E); reactions with water in sodium-heated steam generator, mechanisms of tube wastage from, (E); oxygen content in, Rhometer and oxygen meter response to, (E); purification of, evaluation of centrifuge process for, (E); sampling and analysis of, evaluation of methods for, (E); hydrogen determination in, evaluation of methods for, (E); solvent properties for hydrogen, (E)
BOILERS — tube wastage in sodium-heated steam generators from sodium-water reaction, (E)
RHOMETERS — response of sodium impurity monitoring, to sodium monoxide injections, (E)
GAGES AND METERS — response of sodium impurity monitoring, to sodium monoxide injections, (E)
OXYGEN — monitoring in sodium, response of Rhometer and oxygen meter for, (E)
HYDROGEN — determination in sodium, evaluation of methods for, (E); solubility in sodium, (E)
REACTORS, LIQUID-METAL-COOLED — coolant quality and properties for, determination of sodium, (E)

**47041** (EIR–125) APPLICATION OF LIAPUNOV'S SECOND METHOD TO THE STUDY OF THE STABILITY OF NUCLEAR REACTORS. Burnand, G. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nov. 1967. 83p. (In French). Dep.

A brief summary of Liapunov's second method is given; the basic reactor kinetics equations are stated. Reactor stability criteria are developed. The stability criteria developed by Welton, Smets, and Lur'e-Popov are considered briefly. Use of the Liapunov function for formulation of stability criteria is discussed; basic theorems are given. Stability coefficients and solutions to the stability equations are developed. Explicit conditions for the existence of real solutions are given. Stability limits are estimated. A sample problem is included. 31 references. (M.L.S.)

**47042** (IFA–FR–66) APPLICATIONS OF THE MATRIX CALCULUS TO THE NUCLEAR REACTOR PHYSICS AND TECHNIQUE. Rosescu, T. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 25p. Dep.

A bibliography on the use of matrices and matrix notation in reactor physics calculations is given. The types of problems and areas where matrices are applicable are listed. 236 references. (M.L.S.)

**47043** (IN–1184) TURBO-40: A TWO-DIMENSIONAL NUCLEAR REACTOR DEPLETION PROGRAM FOR THE IBM 7040-44 COMPUTER. Poetschat, G. R. (Idaho Nuclear Corp., Idaho Falls); Wagner, R. J. (Phillips Petroleum Co., Idaho Falls, Idaho). Aug. 1968. Contract AT(10-1)-1230. 87p. Dep. CFSTI.

TURBO-40 is an IBM 7040-44 computer program which obtains a numeric solution to the few-group, time-independent, two-dimensional neutron-diffusion equations with coupling to the linear, first order, ordinary differential equations which describe the build-up and depletion of isotopic number densities over a time interval. The group-averaged macroscopic cross sections for the few-group neutron diffusion equations are computed from fitted few-group microscopic cross sections and isotopic atom densities. The build-up or depletion of isotopic number densities describing the materials present is calculated from the fitted cross sections and the neutron flux. The flux is assumed to be constant over the time interval of each step and is recomputed for each succeeding step. The solution is obtained either over a rectangular surface in X-Y coordinates or over a right cylinder in R-Z coordinates. The number of lethargy groups is two, three, or four, and the total number of mesh points of solution is limited to 20,000. TURBO-40 is a conversion to the IBM 7040-44 of the TURBO program as reported in "Nuclear Reactor Depletion Programs for the Philco-2000 Computer," WAPD-TM-221. A user's guide for the TURBO-40 program is presented. (auth)

**47044** (LA-tr-68-39) NEW ROSSI-$\alpha$-MEASUREMENT METHODS. Edelmann, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronphysik und Reaktortechnik). Translated from report INR-4/68-15. 114p. Dep. CFSTI.

Under certain conditions in Rossi-$\alpha$ measurements the correlation amplitude of pulses may be in error because of dead time in the analyzer or in the neutron detectors. This falsification of the correlation amplitude is examined and measurement methods for determining the undisturbed correlation function are developed. The signal-to-noise ratio was increased by periodic interruption or by scaling the sequence of initiating pulses. Measurements without dead time were simulated with the aid of a magnetic tape instrument. To test the experimental results, the effect of small dead times in the initiating pulse and count-pulse channels on the correlation channel was calculated. Good agreement was obtained between theory and experiment. The statistical measuring errors were included in a general error formula which makes it possible to determine the most favorable testing conditions or to decide in advance whether Rossi-$\alpha$ measurements can be carried out. (H.D.R.)

**47045** (NP-17599, pp 41-4) NUCLEAR FUEL SUPPLIES AND SERVICES OF THE U.K.A.E.A. Bamford, F. W.

The various components of the U.K.A.E.A. fuel service are described. An indication of how the fuel service might operate in support of a reactor of British design constructed in Denmark is presented. (auth)

**47046** (TRG-Report-1694) NUCLEAR FUEL SUPPLY BY THE U.K.A.E.A. Bainbridge, G. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 7p. Dep. CFSTI. UK 2s. 6d.

A brief outline is given of the facilities and services of the U.K.A.E.A. for the manufacture and reprocessing of nuclear fuels, which are available to world markets. (UK)

**47047** (WAPD-TM-794) ANALYSIS OF VOID MIGRATION, CLAD COLLAPSE AND FUEL CRACKING IN BULK OXIDE FUEL RODS (LWBR DEVELOPMENT PROGRAM). Duncombe, E. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1968. Contract AT-11-1-GEN-14. 38p. Dep. CFSTI.

Methods of accounting for void migration, fuel cracking, fuel-clad friction and clad collapse in the analysis of the performance of bulk oxide fuel rods are presented. The required modifications to the CYGRO-2 computer program are specified. The observed coring radius of a fuel rod containing $ThO_2$ 5.6 w/o $UO_2$ is in agreement with the model if suitable allowance is made for fission-induced swelling. In-pile length changes of a non-free-standing test fuel rod containing $ThO_2$ 20 w/o $UO_2$ are also explained on the basis of the fuel cracking model. (auth)

**47048** URANIUM: THE WAY TO PRIVATE ENRICHMENT. Edelson, Edward. New Sci., 39: 380-1(Aug. 22, 1968).

The one function in the US nuclear power industry that has not yet been handed over to private enterprise is the enrichment of uranium. There is now a strong demand for such a move. (auth)

**47049** NOISE AND FLUCTUATION PHENOMENA IN NUCLEAR REACTORS. Williams, M. M. R. (Queen Mary Coll., London). Nucl. Energy, 106-8; 120-2(July-Aug. 1968).

A comparison is made of the various methods available for analysing neutron noise and fluctuation phenomena in nuclear reactors. The physical processes leading to noise in a nuclear chain reactor, and their importance in the understanding of the dynamic characteristics of the system, are discussed. A mathematical model of a stochastic process in a reactor is described, and it is shown how the detector characteristics affect the result. Expressions are derived for the variance of the count rate in a detector and it is shown how this may be related to the correlation function and power spectral density. The probability balance method is compared with the Langevin technique for solving stochastic equations. (auth)

**47050** CALCULATION OF STATIONARY TEMPERATURE DISTRIBUTION FOR FAST REACTOR INTERVALS. Casadei, G. pp 527-35 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

A mathematical model for calculating the stationary temperature distributions for reactor internals is developed. Numerical techniques are used to reduce the second order nonlinear partial differential equations to a system of first order nonlinear ordinary differential equations. 4 references. (M.L.S.)

**47051** BREEDING POTENTIAL OF FAST AND INTERMEDIATE REACTOR CORES BASED ON AETR EXPERIMENTS. Campise, A. V. pp 111-26 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

The feasibility of the fast Th-$^{233}$U nuclear concept is predicted on the nuclear parameters of $^{233}$U fuel. Calculations are made using diffusion theory, perturbation theory, and variational principles. Physics measurements to support the fast Th-$^{233}$U concept are performed in a multi-region, pseudospherical, split-table assembly. 9 references. (D.C.C.)

**47052** CALCULATIONAL STUDY OF $^{239}$Pu-U AND U-$^{233}$Th METAL, CARBIDE, AND OXIDE FAST BREEDER SYSTEMS. Meneghetti, D.; Azzoni, P. M. pp 215-29 of I Reattori Veloci. Rome, Comitato Nazionale Energia Nucleare, 1967.

From 8th Nuclear Congress, Rome, June 1963. See CONF-193-(Vol.2).

Critical masses, internal and total breeding ratios, core and blanket spectra, and Na removal reactivity effects are presented for a series of $^{239}$Pu-U and $^{233}$U-Th systems having metal, carbide, and oxide cores and blankets. The calculations were made for determining the physics of the RAPTUS project. 5 references. (auth)

**47053** FABRICATION OF THORIUM FUEL ELEMENTS. Weissert, L. R.; Schileo, G. Monograph Series on Metallurgy in Nuclear Technology. Hinsdale, Ill., American Nuclear Society, 1968. 217p. (TID-24675).

Comprehensive information is presented on the technology of Th fuel element fabrication. Included are techniques, experience to date, and applications. (H.D.R.)

**47054** CALCULATION OF THE RELEASE OF FISSION PRODUCTS FROM COATED FUEL PARTICLES. Walther, H. (SORIN, Saluggia, Italy). Nukleonik, 11: 171-8(July 1968).

The steady state fractional release of fission products from spherical fuel particles with n concentric coating layers is calculated according to a model based on diffusion, evaporation, and recoil. In a parametrical study, numerical results for monolayer and for triplex coatings are reported in function of dimensionless quantities, which are the real parameters determining the release. These results show quantitatively the influence of such parameters, and also the possible advantages in using triplex-instead of monolayer coatings. With the presently, in high temperature gas cooled reactors used coating materials, plain C or C/SiC/C, the release of the fission gases born in the kernel may with both coating types be limited to fractions lower than $10^{-19}$, while for kernel born $^{140}$Ba fractional releases of more than $4 \times 10^{-3}$ through the monolayer type, and lower than $10^{-6}$ through the triplex type, were evaluated with the presently known data. The results are discussed in view of particle design and in view of the interpretation of release measurements, giving a number of suggestions. (auth)

**47055** UNIFORM CHARGED SOLID PARTICLE PRODUCTION. Erin, T.; Hendricks, C. D. (Univ. of Illinois, Urbana). Rev. Sci. Instrum., 39: 1269-71(Sept. 1968).

A means of producing small uniform spherical solid charged particles is described. A perturbation is applied to a liquid jet which then breaks up into uniform droplets as a result of the Rayleigh instability. The droplets are charged by an electric field as they form. The charged droplets are then frozen by allowing them to fall into an environment whose temperature is below the freezing point of the material. The material used is $NaNO_2$ and the uniform particles can be produced between 90 and 150 $\mu$ in radius while falling a distance of less than 1.5 m. (auth)

**47056** NUCLEAR REACTORS COOLED BY PRESSURISED COOLANT. Thurlbeck, Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,126,084. Sept. 5, 1968. Filed June 15, 1966.

The coolant duct of a reactor pressure vessel is provided with a counterflow brake to restrict the escape of coolant in the event of duct failure. The brake may be used with other flow restrictor devices such as valves to reduce the initial rate of depressurization in a gas-cooled reactor following a cooling system failure. (H.D.R.)

**47057** APPARATUS FOR DETECTING FUEL ELEMENT CAN FAILURES. Douet, Paul; Roguin, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,395,074. July 30, 1968. Priority date Mar. 12, 1965, France.

Method and apparatus capable of detecting fuel element can failures in nuclear reactors which are cooled by circulation of fluid within the channels occupied by the fuel elements are described. A fluid sample is derived from each channel of the reactor via a separate sampling conduit. The plurality of sampling conduits is arranged into a matrix whereby each conduit is a member of at least a line and a column. A number of detector units are used to monitor variations in the radiation level of the group of conduits included in each line and separately the group of conduits included in each column. It is then possible, by comparing the conduit membership of each group which exhibits a variation in radiation level, to individually identify each abnormal fluid sample. Sampling conduits may be arranged into a two or three dimensional matrix which includes lines, columns, rows, and/or random patterns of conduits. Since an abnormal fluid sample will be detected in each group of which it is a member, conduit groupings based upon such more complex patterns may be used to provide a monitoring arrangement of increased reliability whenever necessary. (Offic. Gaz.)

**47058** FUEL ASSEMBLY FOR NUCLEAR REACTORS. Tong, Long Sun; Berringer, Robert T. (to Westinghouse Electric Corp.). U. S. Patent 3,395,077. July 30, 1968. Filed May 25, 1966.

A fuel assembly for a nuclear reactor containing a plurality of spaced parallel fuel elements is provided with means for promoting the mixing of the coolant flowing along coolant channels formed be-

tween adjacent fuel elements. A grid structure having openings therein through which the fuel elements extend is provided with generally planar mixing vanes or coolant deflecting means extending from the grid such that the plane of the deflecting means extends laterally across at least a portion of the adjacent coolant channel. In this manner, mixing of coolant flowing through separate coolant channels is achieved thereby promoting an outlet coolant flow wherein substantially all of the coolant exits from the fuel assembly at substantially the same temperature. (Offic. Gaz.)

**47059** MODULAR SUPPRESSION TANKS FOR NUCLEAR CONTAINMENT STRUCTURES. Stafford, Donald C. (to Chicago Bridge and Iron Co.). U. S. Patent 3,397,113. Aug. 13, 1968. Filed May 10, 1966.

A nuclear reactor containment system in which a number of suppression tanks are spaced about and separated from the drywell vessel is described. A series of vent tubes interconnect the drywell vessel with each individual tank, the tube being supported in the tank by an inside girder and rod structure, with the girder also serving to stiffen the tank for emplacement on a supporting structure. (Offic. Gaz.)

**47060** DEVICE FOR FLOWING FLUIDS IN A SPRAY-COOLING TYPE REACTOR. Torikai, Kinichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-4912. Feb. 22, 1968. Filed Sept. 21, 1965.

Cooling "spray" water, introduced into the bottom reactor-core region from the outside through a pipe, is injected into the individual fuel-cooling channels by nozzles. The heated steam after leaving the reactor is passed through a heat exchanger, a pump, etc., and back to the reactor-core bottom. Part of this heated steam is drawn out, and returned to the reactor core; it is introduced into the individual fuel-cooling channels by use of the suction force supplied by the injected spray water. (NSA of Japan)

# GENERAL

**47061** (AAEC/TM-473) RADIOISOTOPE X-RAY TECHNIQUES FOR APPLICATION TO ON-STREAM ANALYSIS OF MINERAL PRODUCTS. Ellis, W. K.; Fookes, R. A.; Gravitis, V. L.; Watt, J. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1968. 22p. Dep.

Radioisotope x-ray fluorescence and preferential absorption methods for analysis of mineral products are described. These techniques were used to determine zinc, copper, tin, and lead in concentrate, flotation feed, tailing, and residue samples taken from mineral processing plants. The precision obtained was in the range 1 to 10% of the mean element concentration except for copper in tailings. The application of these techniques to on-stream analysis in mineral processing plants is discussed. (auth)

**47062** (CONF-660838) CONFERENCE ON IMPACT OF BIOENGINEERING ON ENGINEERING EDUCATION, AUGUST 29-31, 1966, GATLINBURG, TENNESSEE. (Oak Ridge Associated Universities, Inc., Tenn.). 144p. Dep. CFSTI.

Topics covered at the conference include: measurements, contributions of engineering analysis in the study of living systems, exploration of the potential for applying feedback control concepts in biology and medicine, energy conversion, engineering properties of body tissues and their replacements, prospects for big biology, the eightfold path to bioengineering education, an all-university program in bioengineering, goals for a bioengineering center, requirements of a user, and bioengineering in engineering education. (M.C.G.)

**47063** (IS-T-263) REDUCTION OF NIOBIUM PENTACHLORIDE AND TANTALUM PENTACHLORIDE WITH NIOBIUM METAL IN A GAS CHROMATOGRAPH. Lorine, David John (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 75p. Dep. CFSTI.

Thesis.

A dual column gas chromatograph was used to study the separate reactions of $TaCl_5$ and $NbCl_5$ with niobium metal. The results of a preliminary reduction study confirmed that $NbCl_5$ could be completely reduced by niobium metal to the nonvolatile $NbCl_3$ at a temperature of about 450°C. It was also verified that there is essentially no reduction of $TaCl_5$ by niobium metal under similar conditions. In the studies using the gas chromatograph, ratios of the amount of pentachloride leaving the niobium reduction bed to the amount of pentachloride entering the reduction bed (response ratios) were measured as a function of temperature at a given space time for both $NbCl_5$ and $TaCl_5$. From response ratios measured at 500°C and at different space times, it was concluded that the reduction of $NbCl_5$ with niobium metal is essentially first order. The reaction rate constant was estimated to be 3.14 $sec^{-1}$. Reaction of both $NbCl_5$ and $TaCl_5$ with the stainless steel components of the chromatograph system complicated the study of the reactions of $NbCl_5$ and $TaCl_5$ with niobium metal. Because of this difficulty, the chromatograph was found unsuitable for actual separation studies using mixtures of $NbCl_5$ and $TaCl_5$. Contamination of the $NbCl_5$ samples with niobium oxychloride also complicated the study. However, complete separation of $NbCl_5$ from $NbOCl_3$ was achieved by fractional sublimation. This separation was accomplished by temperature programming from 70 to 220°C. (auth)

**47064** (KFK-738) A PROCEDURE AND A FORTRAN-IV PROGRAM FOR THE SMOOTHING APPROXIMATION OF STEP FUNCTIONS THROUGH SMOOTH CURVES. Spaeth, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1968. 26p. (In German). Dep.

When smoothing step functions, i.e., multigroup spectra, to a weighting function for the calculation of multigroup constants in neutron transport theory, the following problem arises: To a given step function a smooth curve is searched so that the areas below the curves are equal in each of the intervals defined by the discontinuities of the step function. A definition of smooth is given that has been proven to be a good one in practice. The approximation problem is formulated and a numerical method is given to calculate such a smooth and area-preserving curve. Propositions about the existence and uniqueness of such a function can only be made for trivial cases. (auth)

**47065** (LA-3754(Add.)) STROKE- AND SPACE-RESOLVED SLIT SPECTRA OF LIGHTNING. Connor, T. Robert (Los Alamos Scientific Lab., N. Mex.). Mar. 29, 1968. Contract W-7405-eng-36. 35p. Dep. CFSTI.

Twenty-four stroke-resolved slit spectra of lightning taken in 1966 are presented, one of which is also the first space-resolved slit spectrum of a return stroke. These split spectra unambiguously show that the lightning return-stroke channel is a strong continuum source and that the continuum observed is the slitless spectra in 1965 in real and not the result of line radiation scattered from natural backgrounds such as clouds, haze, or rain. (TSS) (auth)

**47066** (SC-DC-68-2396) ELECTROMECHANICAL OSCILLATOR DEVELOPMENT REPORT. Cyrus, Jack D. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1968. Contract AT(29-1)-789. 30p. Dep. CFSTI.

Includes Drawing.

The Electromechanical Oscillator (EMO) is a small (0.25 cubic inch), low power (100 microwatt average), low frequency (3 to 400 Hz), accurate (±0.3%), transistorized, electrically-driven spring-mass oscillator. It has possible uses in devices that require an accurate, low frequency pulse generator, such as a timer or a programmer. It can also be used as a prime mover to drive, at a constant rate, a gear train to close a switch or to move the hands of a watch. (auth)

**47067** (UCRL-18267) BOUNDS FOR THE ROOTS OF CERTAIN POLYNOMIALS AND MATRICES. Hanerfeld, Harold (California Univ., Berkeley. Lawrence Radiation Lab.). June 1968. Contract W-7405-eng-48. 17p. Dep. CFSTI.

Bounds for the roots of polynomials and matrices are sought. A number of such bounds are found for the case where the polynomial has only positive roots. A lower bound for the magnitude of the least root of an arbitrary real polynomial is obtained. By considering matrices in tri-diagonal form, the bounds are extended to matrices. Finally some bounds are given for the least root of a positive definite matrix, depending only on the matrix elements. (auth)

**47068** (UCRL-18345) CHEMICAL SECTIONING METHOD FOR THE MEASUREMENT OF SMALL DIFFUSION COEFFICIENTS IN SOLIDS. Steiger, R. F.; Steel, T. R. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 18p. Dep. CFSTI.

A mathematical analysis of diffusion measurements in silver bromide, obtained by a chemical sectioning method, may lead to a more general application of this simple experimental technique for the determination of small ($10^{-10} - 10^{-14}$ $cm^2$ $s^{-1}$) diffusion coefficients in solids. The mathematical treatment, which involves the exact solution of Fick's law, can be used to establish optimal experimental procedures for the measurement of small diffusion coefficients within a relatively short period of time. (auth)

**47069** ASPECTS DU DROIT DE L'ENERGIE ATOMIQUE. TOME II. INSTITUTIONS NATIONALES ET INTERNATIONALES. LEGISLATIONS FRANCAISE ET ETRANGERES. (Legal Aspects of Atomic Energy. Volume 2. National and International Institutions. French and Foreign Legislations). Puget, Henry. Travaux et Recherches de l'Institut de Droit Compare de l'Universite de Paris, XXXI. Paris, Centre National de la Recherche Scientifique, 1967. 561p. 70 F.

French nuclear laws, the nuclear laws of other countries, and the organization and authority of international organizations connected with the peaceful uses of nuclear energy are considered. In the study of French nuclear laws the administrative problems relative to the peaceful uses of atomic energy in France, demarcation of the respective roles of the state and of private enterprise, and special problems are considered. The nuclear laws of the Federal Republic of Germany, Belgium, the United States of America, Great Britian, Italy, the Netherlands, and Switzerland are reported in detail. These laws are compared with respect to safety and authorization agencies for nuclear installations. The International Agency for Atomic Energy and the European Community for Atomic Energy (EURATOM) are described from a legal viewpoint. (J.S.R.)

# Appendix I

# JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

***Accounts Chem. Res.***
*Accounts of Chemical Research *(U. S.)*
***Acta Anat. Nippon.***
Acta Anatomica Nipponica
*see **Kaibogaku Zasshi***
***Acta Astron.***
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*
***Acta Chir. Scand., Suppl.***
Acta Chirurgica Scandinavica, Supplementum *(Sweden)*
***Acta Cient. Venez., Supl.***
Acta Cientifica Venezolana, Suplemento *(Venezuela)*
***Acta Clin. Belg.***
Acta Clinica Belgica *(Belgium)*
***Acta Dermatol.***
Acta Dermatologica
*see **Hifuka Kiyo***
***Acta Entomol. Bohemoslov.***
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*
***Acta Geod., Geophys. Montanistica***
Acta Geodaetica, Geophysica et Montanistica *(Hungary)*
***Acta Med. Iugoslav.***
Acta Medica Iugoslavica *(Yugoslavia)*
***Acta Paediat. Jap.***
Acta Paediatrica Japonica
*see **Nippon Shonika Gakkai Zasshi***
***Acta Pharm. Hung.***
Acta Pharmaceutica Hungarica *(Hungary)*
***Acta Pharm. Suec.***
Acta Pharmaceutica Suecica *(Sweden)*
***Acta Phys. Chem.***
*Acta Physica et Chemica *(Hungary)*
***Acta Polytech., Chem. Mat. Ser.***
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*
***Acta Sch. Med. Gifu***
Acta Scholae Medicinalis in Gifu
*see **Gifu Ika Daigaku Kiyo***
***Acta Sci. Natur. Univ. Pekin.***
Acta Scientiarum Naturalium Universitatis Pekinensis
*see **Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh***
***Acta Sci. Natur., Univ. Szechuan.***
Acta Scientiarum Naturalium, Universitatis Szechuanensis
*see **Ssu Ch'uan Ta Hsueh Hsueh Pao–Tzu Jan K'o Hsueh***
***Acta Tuberc. Pneumol. Belg.***
Acta Tuberculosea et Pneumologica Belgica *(Belgium)*
***Acta Univ. Carolinae, Med., Monogr.***
Acta Universitatis Carolinae, Medica, Monographia *(Czechoslovakia)*
***Acta Univ. Nankinensis Sci. Natur.***
Acta Universitatis Nankinensis Scientiarum Naturalium
*see **Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh***
***Acta Univ. Upsaliensis, Abstr. Uppsala Diss. Sci.***
Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations in Science *(Sweden)*
***Acta Urol. Jap.***
Acta Urologica Japonica
*see **Hinyokika Kiyo***
***Advan. Colloid Interface Sci.***
Advances in Colloid and Interface Science *(Netherlands)*
***Advan. Contr. Syst.***
Advances in Control Systems *(U. S.)*
***Advan. Cryog. Eng.***
Advances in Cryogenic Engineering *(U. S.)*
***Advan. Nucl. Phys.***
Advances in Nuclear Physics *(U. S.)*
***Advan. Polym. Sci.***
Advances in Polymer Science
*see **Fortschr. Hochpolym.-Forsch.***
***Advan. X-Ray Anal.***
Advances in X-Ray Analysis *(U. S.)*
***Aesthet. Med.***
Aesthetische Medizin *(West Germany)*
***Agr. Hokkaido***
Agriculture in Hokkaido
*see **Hokuno***
***Agr. Hort. (Tokyo)***
Agriculture and Horticulture (Tokyo)
*see **Nogyo Oyobi Engei***
***Agr. Res. (New Delhi)***
Agricultural Research (New Delhi) *(India)*
***Air Clean.***
Air Cleaning
*see **Kuki Seijo***
***Air Water Pollut.***
*Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*
***Ala. J. Med. Sci.***
Alabama Journal of Medical Sciences, The *(U. S.)*
***Allg. Prakt. Chem.***
Allgemeine und Praktische Chemie *(Austria)*
***Allg. Waermetech.***
Allgemeine Waermetechnik *(West Germany)*
***Alloy Dig. Zr-3***
Alloy Digest Zr-3 *(U.S.)*
***Amer. Ass. Petrol. Geol. Bull.***
American Association of Petroleum Geologists Bulletin *(U. S.)*
***Amer. Dyestuff Rep.***
American Dyestuff Reporter *(U. S.)*
***Amer. Eng.***
American Engineer *(U. S.)*
***Amer. J. Med. Technol.***
American Journal of Medical Technology *(U. S.)*
***Amer. Mach./Metalwork. Mfg.***
American Machinist/Metalworking Manufacturing *(U. S.)*
***Amino Acid Nucl. Acid***
Amino Acid and Nucleic Acid
*see **Hakko To Taisho***
***Anaesthesist***
Anaesthesist *(West Germany)*
***Anal. Lett.***
Analytical Letters *(U. S.)*
***Ann. Abeille***

Annales de l'Abeille *(France)*
**Ann. Acad. Sci. Fenn., Ser. A IV**
Annales Academiae Scientiarum Fennicae, Series A IV *(Finland)*
**Ann. Bot. Fenn.**
Annales Botanici Fennici *(Finland)*
**Ann. Dent.**
Annals of Dentistry *(U. S.)*
**Ann. Oto-Laryngol.**
Annales d'Oto-Laryngologie *(France)*
**Annot. Zool. Jap.**
*Annotationes Zoologicae Japonenses *(Japan)*
**Ann. Phytopathol. Soc. Jap.**
Annals of the Phytopathological Society of Japan
see *Nippon Shokubutsu Byori Gakkaiho*
**Ann. Ponts Chaussees**
Annales des Ponts et Chaussees *(France)*
**Ann. Sanita Pubblica**
Annali della Sanita Pubblica *(Italy)*
**An. Stiint. Univ. Al. I. Cuza, Iasi, Sect. I**
Analele Stiintifice ale Universitatii Al. I. Cuza, din Iasi, Sectiunea I *(Romania)*
**Annu. ISA (Instrum. Soc. Amer.) Conf. Proc.**
Annual ISA (Instrument Society of America) Conference Proceedings *(U. S.)*
**Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. DD**
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio DD *(Poland)*
**Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.**
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*
**Annu. Rep. Lab. Public Health, Hiroshima Prefect.**
Annual Report of the Laboratory of Public Health, Hiroshima Prefecture
see *Hiroshima Ken Eisei Kenkyushoho*
**Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ.**
Annual Report of the Research Institute of Environmental Medicine, Nagoya University *(Japan)*
**Annu. Rep. Res. Inst. Tuberc., Kanazawa Univ.**
Annual Report of the Research Inst. of Tuberculosis, Kanazawa University
see *Kanazawa Daigaku Kekkaku Kenkyusho Nenpo*
**Annu. Rep. Sankyo Res. Lab.**
Annual Report of Sankyo Research Laboratory
see *Sankyo Kenkyusho Nenpo*
**Annu. Rep. Shionogi Res. Lab.**
Annual Report of Shionogi Research Laboratory
see *Shionogi Kenkyusho Nenpo*
**Annu. Rev. Genet.**
Annual Review of Genetics *(U.S.)*
**Antimicrob. Agents Chemother.**
Antimicrobial Agents and Chemotherapy *(U. S.)*
**An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.**
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*
**Apicultura (Bucharest)**
Apicultura (Bucharest) *(Romania)*
**Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen**
Arbeitsgemeinschaft fuer Forschung des Landes Nordrhein-Westfalen *(West Germany)*
**Arbeitsmed.-Sozialmed.-Arbeitshyg.**
Arbeitsmedizin-Sozialmedizin-Arbeitshygiene *(West Germany)*
**Arch. Chir. Neer.**
Archivum Chirurgicum Neerlandicum *(Netherlands)*
**Arch. Hist. Exact. Sci.**
Archive for History of Exact Sciences *(West Germany–U. S.)*
**Arch. Jap. Chir.**
Archiv fuer Japanische Chirurgie
see *Nippon Geka Hokan*
**Arch. Klin. Exp. Ohren-, Nasen- Kehlkopfheilk.**
Archiv fuer Klinische und Experimentelle Ohren-, Nasen- und Kehlkopfheilkunde *(West Germany)*
**Arch. Meteorol., Geophys. Bioklimatol., Ser. B**
Archive fuer Meteorologie, Geophysik und Bioklimatologie, Series B *(Austria)*
**Arch. Mineral.**
Archiwum Mineralogiczne *(Poland)*
**Arch. Neer. Sci. Exactes Natur.**
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*
**Arch. Phys. Ther.**
Archiv fuer Physikalische Therapie, Balneologie und Klimatologie *(East Germany)*
**Arch. Sci. (Geneva)**
Archives des Sciences (Geneva) *(Switzerland)*
**Arch. Stomatol.**
Archivio Stomatologico *(Italy)*
**Ark. Zool.**
Arkiv for Zoologi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*
**ASM (Amer. Soc. Metals), Trans. Quart.**
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*
**ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.**
ASTM (American Society for Testing and Materials) Special Technical Publication *(U. S.)*
**Astrofizika**
Astrofizika *(Armenian S.S.R.)*
**Astron. Tsirk.**
Astronomicheskii Tsirkulyar *(U.S.S.R.)*
**Astrophysics (Engl. Transl.)**
*Astrophysics (English Translation of Astrofizika) *(U. S.)*
**Astrophys. Lett.**
*Astrophysical Letters *(Scotland)*
**Astrophys. Space Sci.**
*Astrophysics and Space Science *(Netherlands)*
**At. Absorption Newslett.**
Atomic Absorption Newsletter *(U. S.)*
**Ateneo Parmense, Sez. 1**
Ateneo Parmense, Sezione 1. Acta Bio-Medica *(Italy)*
**At. Energy (China)**
Atomic Energy (China)
see *Yuen Tzu Nang*
**At. Energy Bull.**
Atomic Energy Bulletin
see *Genshiryoku Shiryo*
**At. Energy Law J.**
Atomic Energy Law Journal *(U. S.)*
**Atmos. Environ.**
*Atmospheric Environment *(England)*
**Atti Accad. Med. Lombarda**
Atti della Accademia Medica Lombarda *(Italy)*
**Aust. J. Mar. Freshwater Res.**
Australian Journal of Marine and Freshwater Research *(Australia)*
**Aust. J. Zool.**
Australian Journal of Zoology *(Australia)*
**Aust. Mach. Prod. Eng.**
Australian Machinery and Production Engineering *(Australia)*
**Australas. Mfr.**
Australasian Manufacturer *(Australia)*
**Automat. Electron.**
Automatica si Electronica *(Romania)*
**Automaz. Strum.**
Automazione e Strumentazione *(Italy)*
**Aviat. Week Space Technol.**
Aviation Week and Space Technology *(U. S.)*
**Bautechnik**
Bautechnik, Die *(West Germany)*
**Beitr. Biol. Pflanz.**
Beitraege zur Biologie der Pflanzen *(West Germany)*
**Ber. Deut. Ges. Geol. Wiss., Reihe B**
Berichte der Deutschen Gesellschaft fuer Geologische Wissenschaften, Reihe B. Mineralogie und Lagerstaettenforschung *(East Germany)*
**Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben**
Berg- und Huettenmaennische Monatshefte der Montanistischen Hochschule in Leoben *(West Germany)*
**Berlin. Wetterkarte, Suppl.**
Berliner Wetterkarte, Supplement *(West Germany)*
**Ber. Schweiz. Bot. Ges.**
Berichte der Schweizerischen Botanischen Gesellschaft *(Switzerland)*
**Beton Zhelezobeton**
Beton i Zhelezobeton *(Georgian S.S.R.)*
**Biol. Nauki**
Biologicheskie Nauki *(U.S.S.R.)*
**Biol. Plant., Acad. Sci. Bohemoslov.**
Biologia Plantarum, Academia Scientarum Bohemoslovenica *(Czechoslovakia)*
**Biol. Rundsch.**
Biologische Rundschau *(East Germany)*
**Bioscience**
Bioscience *(U. S.)*
**Biul. Wojsk. Akad. Tech.**
Biulatyn Wojskowej Akademii Technicznej imeni Jaroslawa Dabrowskiego *(Poland)*
**Blech**
Blech *(West Germany)*
**BNX Rev.**

BNX Review *(England)*

**Bodenkultur**
Bodenkultur, Die *(Austria)*

**Boll. Inst. Entomol. Agr. Osserv. Fitopatol. Palermo**
Bollettino dell'Istituto di Entomologia Agraria e dell'Osservatorio di Fitopatologia di Palermo *(Italy)*

**Boll. Zool.**
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*

**Bol. Univ. Fed. Parana, Fis. Teor.**
*Boletim da Universidade Federal do Parana, Fisica Teorica *(Brazil)*

**Brain Res.**
Brain Research *(Netherlands)*

**Brit. Food J.**
British Food Journal *(England)*

**Brit. J. Dis. Chest**
British Journal of Diseases of the Chest *(England)*

**Brit. J. Plast. Surg.**
British Journal of Plastic Surgery *(Scotland)*

**Brit. Mycol. Soc. Trans.**
British Mycological Society Transactions, The *(England)*

**Brit. Plast.**
British Plastics *(England)*

**Broad Way Clin. Suppl.**
Broad Way Clinical Supplement *(England)*

**Build. Eng.**
Building Engineering
**see Kenchiku Gijutsu**

**Bul. Inst. Politeh. Gheorghe Gheorghiu-Dej Bucuresti**
Buletinul Institutului Politehnic Gheorghe Gheorghiu-Dej Bucuresti *(Romania)*

**Bull. Astron.**
Bulletin Astronomique *(France)*

**Bull. Astron. Inst. Neth.**
Bulletin of the Astronomical Institutes of the Netherlands *(Netherlands)*

**Bull. Astron. Inst. Neth., Suppl. Ser.**
Bulletin of the Astronomical Institutes of the Netherlands, Supplement Series *(Netherlands)*

**Bull. Belgicatom**
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Paficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

**Bull. Belg. Phys. Soc.**
Bulletin of the Belgian Physical Society (formerly Bulletin de la Societe Belge de Physique) *(Belgium)*

**Bull. Brew. Sci.**
*Bulletin of Brewing Science *(Japan)*

**Bull. Calcutta Math. Soc.**
Bulletin of the Calcutta Mathematical Society *(India)*

**Bull. Dir. Etud. Rech.**
Bulletin de la Direction des Etudes et Recherches *(France)*

**Bull. Earthquake Res. Inst., Univ. Tokyo**
Bulletin of the Earthquake Research Inst., University of Tokyo
**see Tokyo Daigaku Jishin Kenkyusho Iho**

**Bull. Eidgenoess. Gesundh., Beil. B**
Bulletin des Eidgenoessisches Gesundheitsamtes, Beilage B *(Switzerland)*

**Bull., Eng. Geol. Hydrogeol. (Engl. Transl.)**
Bulletin, Engineering Geology and Hydrogeology (English Translation of Vesnik Zavoda za Geoloska i Geofizicka Istrazivanja, Serija B) *(Yugoslavia)*

**Bull. Entomol. Res.**
Bulletin of Entomological Research *(England)*

**Bull. Fac. Eng., Hiroshima Univ.**
Bulletin of the Faculty of Engineering, Hiroshima University
**see Hiroshima Daigaku Kogakubu Kenkyu Hokoku**

**Bull. Fac. Sci. Eng., Chuo Univ.**
Bulletin of the Faculty of Science and Engineering, Chuo University
**see Chuo Daigaku Rikogakubu Kiyo**

**Bull. Geophys. Observ., Haile Sellassie I Univ.**
Bulletin of the Geophysical Observatory, Haile Sellassie I University *(Ethopia)*

**Bull. Govt. Ind. Res. Inst., Osaka**
Bulletin of the Government Industrial Research Institute, Osaka
**see Osaka Kogyo Gijutsu Shikensho Kiho**

**Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl.**
*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire), Supplement *(France)*

**Bull. Inst. Geophys., Nat. Cent. Univ.**
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*

**Bull. Inst. Int. Froid, Annexe**
Bulletin de l'Institut International du Froid, Annexe *(France)*

**Bull. Inst. Nat. Sante Rech. Med.**
Bulletin de l'Institut National de la Sante et de la Recherche Medicale *(France)*

**Bull. Instrum. Nucl.**
*Bulletin Instrumentation Nucleaire (formerly Instrumentation Nucleaire) Supplement au Bulletin d'Informations Scientifiques et Techniques *(France)*

**Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo**
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
**see Tokyo Daigaku Uchu Koku Kenkyusho Hokoku**

**Bull Int. Inst. Refrig., Suppl.**
Bulletin of the International Institute of Refrigeration, Supplement
**see Bull. Inst. Int. Froid, Annexe**

**Bull. Kyoto Educ. Univ., Ser. B**
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*

**Bull. Kyushu Inst. Technol., Math., Natur. Sci.**
*Bulletin of the Kyushu Inst. of Technology, Mathematics, Natural Science *(Japan)*

**Bull. Nat. Inst. Anim. Ind. (Jap.)**
Bulletin of the National Inst. of Animal Industry (Japan)
**see Chikusan Shikenjo Kenkyu Hokoku**

**Bull. Nat. Inst. Sci. India**
Bulletin of the National Institute of Sciences of India *(India)*

**Bull. Oerlikon**
Bulletin Oerlikon *(Switzerland)*

**Bull. Office Int. Epizoot.**
Bulletin de l'Office International des Epizooties *(France)*

**Bull. Osaka Munic. Tech. Res. Inst.**
Bulletin of the Osaka Municipal Technical Research Inst.
**see Osaka Shiritsu Kogyo Kenkyusho Hokoku**

**Bull. Res. Inst. Ferment., Yamanashi Univ.**
Bulletin of the Research Inst. of Fermentation, Yamanashi University
**see Yamanashi Daigaku Hakko Kenkyusho Kenkyu Hokoku**

**Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.**
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
**see Tohoku Daigaku Senko Seiren Kenkyusho Iho**

**Bull. Soc. Roy. Bot. Belg.**
Bulletin de la Societe Royale de Botanique de Belgique *(Belgium)*

**Bull. Soc. Sea Water Sci., Jap.**
Bulletin of the Society of Sea Water Science, Japan
**see Nippon Kaisui Gakkaishi**

**Bull. Tulane Univ. Med. Fac.**
Bulletin of the Tulane University Medical Faculty *(U.S.)*

**Bull. Volcanol.**
Bulletin Volcanologique *(Italy)*

**Bul. Stiint. Teh. Inst. Politeh. Timisoara**
Buletinul Stiintific si Tehnic al Institutului Politehnic Timisoara *(Romania)*

**Bus. Rev., Univ. Wash.**
Business Review, University of Washington *(U. S.)*

**Bus. Syst. Equip.**
Business Systems and Equipment *(England)*

**Bus. Week**
Business Week *(U. S.)*

**Byggmesteren**
Byggmesteren (Norges Byggforskningsinstitutt) *(Norway)*

**Byull. Inst. Teor. Astron.**
Byulleten Instituta Teoreticheskoi Astronomii *(U.S.S.R.)*

**Byull. Kom. Oprod. Absol. Geol. Form.**
Byulleten Komissii po Opredeleniyu Absolyutnogo Vozrasta Geologicheskikh Formatsii *(U.S.S.R.)*

**Byull. Mosk. Obshch. Ispyt. Prir., Otd. Biol.**
Byulleten Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii *(U.S.S.R.)*

**CA–Cancer J. Clin.**
CA– Cancer Journal Clinicians *(U.S.)*

**Cah. Ing. Agron.**
Cahiers des Ingenieurs Agronomes *(France)*

**Cah. Oceanogr.**
Cahiers Oceanographiques *(France)*

**Calcified Tissue Res.**
Calcified Tissue Research *(West Germany)*

**Can. Hosp.**
Canadian Hospital *(Canada)*

**Can. J. Ophthalmol.**
Canadian Journal of Ophthalmology *(Canada)*

**Can. J. Psychol.**
Canadian Journal of Psychology *(Canada)*

**Can. Mach. Metalwork.**
Canadian Machinery and Metalworking *(Canada)*

**Canner/Packer**
Canner/Packer *(U. S.)*
**Can. Nurse**
Canadian Nurse *(Canada)*
**Catalyst (Tokyo)**
Catalyst (Tokyo)
*see Shokubai*
**Cell Tissue Kinet.**
*Cell and Tissue Kinetics *(England)*
**Celul. Hirtie**
*Celuluza si Hirtie *(Romania)*
**Cent. Afr. J. Med.**
Central African Journal of Medicine *(Rhodesia)*
**Corcet. Met.**
Corcetari Metalurgice *(Romania)*
**Cereal Sci. Today**
Cereal Science Today *(U. S.)*
**Chartered Mech. Eng.**
Chartered Mechanical Engineer *(England)*
**Chem. Age India**
Chemical Age of India *(India)*
**Chem. Eng., Jap.**
Chemical Engineering, Japan
*see Kagaku Kogaku*
**Chem. Heterocycl. Compounds (USSR) (Engl. Transl.)**
Chemistry of Heterocyclic Compounds (USSR) (English Translation of Khimiya Geterotsiklicheskikh Soedinenii) *(U. S.)*
**Chem. Instrum.**
*Chemical Instrumentation *(U. S.)*
**Chemotherapy (Tokyo)**
*Chemotherapy (Tokyo) *(Japan)*
**Chem. Pharm. Bull.**
*Chemical and Pharmaceutical Bulletin *(Japan)*
**Chem. Process. (London)**
Chemical Processing (London) *(England)*
**Chem. Rundsch. (Solothurn)**
Chemische Rundschau (Solothurn) *(Switzerland)*
**Chesapeake Sci.**
Chesapeake Science *(U. S.)*
**Chiba Igakkai Zasshi**
*Chiba Igakkai Zasshi (The Journal of Chiba Medical Society) *(Japan)*
**Chicago Med. Sch. Quart.**
Chicago Medical School Quarterly *(U. S.)*
**Chikusan Shikenjo Kenkyu Hokoku**
*Chikusan Shikenjo Kenkyu Hokoku (Bulletin of the National Inst. of Animal Industry) *(Japan)*
**Chikyu Kagaku**
*Chikyu Kagaku (Earth Science) *(Japan)*
**Chim. Ind., Genie Chim.**
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*
**Chin. Agr. Sci.**
Chinese Agricultural Science
*see Chung Kuo Nung Yeh K'o Hsueh*
**Chin. Anim. Husb. Vet. Med.**
Chinese Animal Husbandry and Veterinary Medicine
*see Chung Kuo Hsu Mu Shou I*
**Chin. J. Dermatol.**
Chinese Journal of Dermatology
*see Chung Hua P'i Fu K'o Tsa Chih*
**Chin. J. Gynecol. Obstet.**
Chinese Journal of Gynecology and Obstetrics
*see Chung Hua Fu Ch'an K'o Tsa Chih*
**Chin. J. Phys. (Peking) (Engl. Transl.)**
*Chinese Journal of Physics (Peking) (English Translation of Acta Physica Sinica (Wu Li Hsueh Pao)) *(U. S.)*
**Chin. J. Surg.**
Chinese Journal of Surgery
*see Chung Hua Wai K'o Tsa Chih*
**Chromatographia**
Chromatographia *(West Germany)*
**Chung Hua Fu Ch'an K'o Tsa Chih**
Chung Hua Fu Ch'an K'o Tsa Chih (Chinese Journal of Gynecology and Obstetrics) *(China)*
**Chung Hua I Hsueh Tsa Chih**
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*
**Chung Hua P'i Fu K'o Tsa Chih**
Chung Hua P'i Fu K'o Tsa Chih (Chinese Journal of Dermatology) *(China)*
**Chung Hua Wai K'o Tsa Chih**
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*
**Chung Kuo Hsu Mu Shou I**
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*
**Chung Kuo Nung Yeh K'o Hsueh**
Chung Kuo Nung Yeh K'o Hsueh (Chinese Agricultural Science) *(China)*
**Chuo Daigaku Rikogakubu Kiyo**
Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*
**Civil Eng. (N. Y.)**
Civil Engineering (New York) *(U. S.)*
**Civil Eng. Public Works Rev.**
Civil Engineering and Public Works Review *(England)*
**Clay Sci. (Tokyo)**
Clay Science (Tokyo) *(Japan)*
**Cleveland Clin. Quart.**
Cleveland Clinic Quarterly *(U. S.)*
**Clin. Med.**
Clinical Medicine *(U. S.)*
**Coal Age**
Coal Age *(U. S.)*
**Cobalt**
Cobalt *(France)*
**Colloid J. (USSR) (Engl. Transl.)**
Colloid Journal (USSR) (English Translation of Kolloidnyi Zhurnal) *(U. S.)*
**Colloq. Int. Cent. Nat. Rech. Sci.**
Colloques Internationaux du Centre National de la Recherche Scientifique *(France)*
**Colo., Agr. Exp. Sta., Tech. Bull.**
Colorado State University, Agricultural Experiment Station, Technical Bulletin *(U. S.)*
**Colo. Sch. Mines, Miner. Ind. Bull.**
Colorado School of Mines, Mineral Industries Bulletin *(U. S.)*
**Combustion**
Combustion *(U.S.)*
**Commer. Fish. Rev.**
Commercial Fisheries Review *(U. S.)*
**Commun. Math. Phys.**
Communications in Mathematical Physics *(West Germany)*
**Compt. Rend. Ass. Anat.**
Comptes Rendus de l'Association des Anatomistes *(France)*
**Compt. Rend. Soc. Geol. Fr.**
Compte Rendu Sommaire des Seances de la Societe Geologique de France *(France)*
**Comput. Biomed. Res.**
Computers and Biomedical Research *(U. S.)*
**Concrete J.**
Concrete Journal
*see Konkurito Janaru*
**Constr. Masini**
Constructia de Masini *(Romania)*
**Constructor**
Constructor *(U. S.)*
**Coord. Chem. Rev.**
Coordination Chemistry Reviews *(Netherlands)*
**Corros. Prev. Contr.**
Corrosion Prevention and Control *(England)*
**Cuivre, Laitons, Alliages**
Cuivre, Laitons, Alliages *(France)*
**Curr. Awareness Bull.**
Current Awareness Bulletin *(U. S.)*
**Curr. Mod. Biol.**
Currents in Modern Biology *(Netherlands)*
**Czas. Stomatol.**
Czasopismo Stomatologiczne *(Poland)*
**Dan. Med. Bull.**
Danish Medical Bulletin *(Denmark)*
**Denki Shikenjo Kenkyu Hokoku**
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*
**Dermatol. Int.**
Dermatologia Internationalis *(U. S.)*
**Desalination**
Desalination *(Netherlands)*
**Des. Components Eng.**
Design and Components in Engineering *(England)*
**Deut. Apoth.-Ztg.**
Deutsche Apotheker-Zeitung Vereinigt mit Sueddeutsche Apotheker-Zeitung *(West Germany)*
**Deut. Hydrogr. Z.**
Deutsche Hydrographische Zeitschrift *(West Germany)*
**Deut. Zahn-, Mund- Kieferheilk.**
Deutsche Zahn-, Mund- und Kieferheilkunde mit Zentralblatt fuer die Gesamte Zahn-, Mund- und Kieferheilkunde *(East Germany)*

**Deut. Z. Gesam. Gerichtl. Med.**
Deutsche Zeitschrift fuer die Gesamte Gerichtliche Medizin *(West Germany—U. S.)*

**Diffus. Data**
*Diffusion Data *(U. S.)*

**DMIC Rev.**
DMIC Review of Recent Developments *(U. S.)*

**Doboku Gijutsu**
Doboku Gijutsu (Civil Engineering) *(Japan)*

**Doc-Air-Espace**
*Doc-Air-Espace *(France)*

**Dokl.—Bot. Sci. Sect. (Engl. Transl.)**
Doklady—Botanical Sciences Sections (English Translation) *(U.S.)*

**Dokl. TSKhA (Timiryazev. Sel'skokhoz. Akad.)**
Doklady TSKhA (Timiryazevskaya Sel'skokhozyaistvennaya Akademiya) *(U.S.S.R.)*

**Dokl. Vses. Akad. Sel'skokhoz. Nauk**
Doklady Vsesoyuznoi Akademii Sel'skokhozyaistvennykh Nauk im. V. I. Lenina *(U.S.S.R.)*

**Drevo**
Drevo *(Czechoslovakia)*

**Earth Sci. (Tokyo)**
Earth Science (Tokyo)
**see *Chikyu Kagaku***

**Earth-Sci. Rev.**
Earth-Science Reviews *(Netherlands)*

**Eau**
Eau, L' *(France)*

**Eiyo To Shokuryo**
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*

**Ekon. Samf. Tidskr.**
Ekonomiska Samfundets Tidskrift *(Sweden)*

**Electron. Equip. News**
Electronic Equipment News *(England)*

**Electron. Ind. (Paris).**
Electronique Industrielle (Paris) *(France)*

**Electron. Packag. Prod.**
Electronic Packaging and Production *(U. S.)*

**Electrotech. J. Jap.**
*Electrotechnical Journal of Japan *(Japan)*

**Electrotechniek**
Electrotechniek *(Netherlands)*

**Elec. World**
Electrical World *(U. S.)*

**Elec. World (Shanghai)**
Electrical World (Shanghai)
**see *Tien Shih Chieh***

**Elektrizitaetsverwertung**
Elektrizitaetsverwertung *(Switzerland)*

**Elektromedizin**
Elektromedizin und Ihre Grezgebiete *(Germany)*

**Elektron. Bol'shikh Moshch.**
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*

**Elektron. Obrab. Mater.**
Elektronnaya Obrabotka Materialov *(Moldavian S.S.R.)*

**Elektron. Rechenanlagen**
Elektronische Rechenanlagen *(West Germany)*

**Elektrotech. Cas.**
Elektrotechnicky Casopis *(Czechoslovakia)*

**Elektrotekhnika**
Elektrotekhnika *(U.S.S.R.)*

**Elektr. Sta.**
Elektricheskie Stantsii *(U.S.S.R.)*

**Energetika**
*Energetika *(Czechoslovakia)*

**Engei Gakkai Zasshi**
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*

**Engl. Elec. J.**
English Electric Journal *(England)*

**Entropie**
Entropie *(France)*

**Environ. Health**
Environmental Health *(India)*

**Environ. Res.**
Environmental Research *(U. S.)*

**EPE, Rev. Energ. Primaire**
EPE, Revue Energie Primaire
**see *Rev. Energ. Primaire***

**Ergonomics**
Ergonomics *(England)*

**Euphytica**
Euphytica *(Netherlands)*

**Euratom Rev.**
*Euratom Review of the European Atomic Energy Community (formerly Euratom Bulletin) *(Belgium)*

**Exp. Pathol.**
Experimentelle Pathologie *(East Germany)*

**Farm, Ranch, Home Quart.**
Farm, Ranch and Home Quarterly *(U. S.)*

**FDA (Food Drug Admin.) Pap.**
FDA (Food and Drug Administration) Papers *(U. S.)*

**Fette-Seifen-Anstrichm.**
Fette-Seifen-Anstrichmittel (combined with Ernaehrungsindustrie) *(West Germany)*

**Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.**
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*

**Fiziol. Norm. Patol. (Bucharest)**
Fiziologia Normala si Patologica (Bucharest) *(Romania)*

**Fiz. Khim. Obrab. Mater.**
Fizika i Khimiya Obrabotki Materialov *(U.S.S.R.)*

**Fiz. Tekh. Poluprov.**
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*

**Flame Notes, Beckman**
Flame Notes, Beckman *(U. S.)*

**Flug-Rev. Int.**
Flug-Revue International *(West Germany)*

**FOA (Forsvarets Forsk.) Rep.**
*FOA (Forsvarets Forskningsanstalt) Reports *(Sweden)*

**Folia Haematol. (Leipzig)**
Folia Haematologia (Leipzig) *(East Germany)*

**Folia Med. Cracov.**
Folia Medica Cracoviensia *(Poland)*

**Folia Pharm. Jap.**
Folia Pharmacologica Japonica
**see *Nippon Yakurigaku Zasshi***

**Food Eng. (Philadelphia)**
Food Engineering (Philadelphia) (formerly Food Industries) *(U. S.)*

**Forest. Abstr.**
Forestry Abstracts *(England)*

**Forsch. Ingenieurw.**
Forschung im Ingenieurwesen *(West Germany)*

**Fortschr. Hochpolym.-Forsch.**
Fortschritte der Hochpolymeren-Forschung *(West Germany)*

**Fortschr. Zool.**
Fortschritte de Zoologie *(West Germany)*

**Foundry**
Foundry *(U. S.)*

**Freiberg. Forschungsh., B**
Freiberger Forschungshefte, Reihe B *(East Germany)*

**Fuji Shashin Fuirumu Kenkyu Hokoku**
*Fuji Shashin Fuirumu Kenkyu Hokoku (Scientific Publications of the Fuji Photo Film Co., Ltd.) *(Japan)*

**Fukuoka Acta Med.**
Fukuoka Acta Medica
**see *Fukuoka Igaku Zasshi***

**Fukuoka Igaku Zasshi**
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*

**Fukushima Daigaku Gakugei Gakubu Rika Hokoku**
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*

**Fune No Kagaku**
Fune No Kagaku (Marine Engineering) *(Japan)*

**Genet. Pol.**
*Genetica Polonica *(Poland)*

**Genshiryoku Shiryo**
Genshiryoku Shiryo (Atomic Energy Bulletin) *(Japan)*

**Geofiz. App.**
Geofizicheskaya Apparatura *(U.S.S.R.)*

**Geofiz. Byull.**
Geofizicheskii Byulleten *(U.S.S.R.)*

**Geofys. Sb.**
Geofysikalni Sbornik *(Czechoslovakia)*

**Geol. Geofiz.**
Geologiya i Geofizika *(U.S.S.R.)*

**Geol. Mag.**
Geological Magazine *(England)*

**Geol. Nefti Gaza**
Geologiya Nefti i Gaza† *(U.S.S.R.)*

**Geol. Soc. Amer., Spec. Pap.**
Geological Society of America, Special Paper *(U. S.)*

**Geophys. Geol. (Leipzig)**
Geophysik und Geologie (Leipzig) *(East Germany)*

**Gidroaeromekhanika**
Gidroaeromekhanika *(Ukrainian S.S.R.)*

**Gidrokhim. Mater.**
Gidrokhimicheskie Materialy *(U.S.S.R.)*

***Giesserei***
Giesserei *(West Germany)*
***Gifu Ika Daigaku Kiyo***
*Gifu Ika Daigaku Kiyo (Acta Scholae Medicinalis in Gifu) *(Japan)*
***G-I-T (Glas- Instrum.-Tech.) Fachz. Lab.***
G-I-T (Glas- und Instrumenten-Technik) Fachzietschrift fuer das Laboratorium *(West Germany)*
***Glas-Instrum.-Tech.***
Glas-Instrumenten-Technik *(West Germany)*
***Glass Ceram. (USSR) (Engl. Transl.)***
Glass and Ceramics (USSR) (English Translation of Steklo i Keramika) *(U. S.)*
***Gorn. Zh.***
Gornyi Zhurnal *(U.S.S.R.)*
***Grinding Finish.***
Grinding and Finishing *(U. S.)*
***Guoisuanyan Xuebao***
Guoisuanyan Xuebao
*see Kuei Suan Yen Hsueh Pao*
***Haematologia (Budapest)***
Haematologia (Budapest) *(Hungary)*
***Haikan Gijutsu***
Haikan Gijutsu (The Piping Engineering) *(Japan)*
***Hakko To Taisha***
*Hakko To Taisha (Amino Acid and Nucleic Acid) *(Japan)*
***Handb. Med. Radiol.***
Handbuch der Medizinschen Radiologie *(West Germany)*
***Harper Hosp. Bull.***
Harper Hospital Bulletin *(U. S.)*
***Hawaii Farm Sci.***
Hawaii Farm Science *(U. S.)*
***Health Lab. Sci.***
Health Laboratory Science *(U. S.)*
***Heidelberg. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber.***
Heidelberger Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte *(West Germany)*
***Hemel Dampkring***
Hemel en Dampkring *(Belgium)*
***Hifuka Kiyo***
*Hifuka Kiyo (Acta Dermatologica) *(Japan)*
***Hinyokika Kiyo***
*Hinyokika Kiyo (Acta Urologica Japonica) *(Japan)*
***Hiroshima Daigaku Kogakubu Kenkyu Hokoku***
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*
***Hiroshima Ken Eisei Kenkyushoho***
*Hiroshima Ken Eisei Kenkyushoho (Annual Report of the Laboratory of Public Health, Hiroshima Prefecture) *(Japan)*
***Hodowla Rosl., Aklim. Nasien.***
Hodowla Roslin, Aklimatyzacja i Nasiennictwo *(Poland)*
***Hoken Butsuri***
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*
***Hokkaidoritsu Eisei Kenkyushoho***
Hokkaidoritsu Eisei Kenkyushoho (Report of the Hokkaido Inst. of Public Health) *(Japan)*
***Hokuno***
Hokuno (Agriculture in Hokkaido) *(Japan)*
***Honvedorvos***
Honvedorvos *(Hungary)*
***Hyg. Sanit. (USSR) (Engl. Transl.)***
Hygiene and Sanitation (USSR) (English Translation of Gigiena i Sanitariya) *(U. S.)*
***Hyogo Naka Daigaku Kiyo***
Hyogo Naka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*
***Idengaku Zasshi, Suppl.***
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*
***IEEE (Inst. Elec. Electron. Eng.) Trans. Audio Electroacoust.***
*IEEE (Institute of Electrical and Electronics Engineers) Transactions on Audio and Electroacoustics *(U.S.)*
***Ig. Sanita Pubblica***
Igiene e Sanita Pubblica *(Italy)*
***Ind. Aliment. Agr. (Paris)***
Industries Alimentaires et Agricoles (Paris) *(France)*
***Ind.-Anz.***
Industrie-Anzeiger *(West Germany)*
***Ind.-Elektron. Forsch. Fertigung***
Industrie-Elektronik in Forschung und Fertigung *(West Germany)*
***Index Litt. Nucl. Fr.***
*Index de la Litterature Nucleaire Francaise *(France)*
***Indian Food Packer***
Indian Food Packer *(India)*
***Indian J. Agr. Sci.***
Indian Journal of Agricultural Science, The *(India)*
***Indian J. Appl. Chem.***
Indian Journal of Applied Chemistry *(India)*
***Indian J. Cancer***
Indian Journal of Cancer *(India)*
***Indian J. Occup. Health***
Indian Journal of Occupational Health *(India)*
***Indian J. Pathol. Bacteriol.***
Indian Journal of Pathology and Bacteriology *(India)*
***Indian Pediat.***
Indian Pediatrics *(India)*
***Ind. Mineraria***
Industria Mineraria *(Italy)*
***Ind. Process Heat.***
Industrial and Process Heating *(England)*
***Ind. Water Eng.***
Industrial Water Engineering *(U. S.)*
***Inform. Byull. Sov. Antarkt. Eksped.***
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*
***Ing. Bygningsv., Ugeovers.***
Ingenieor- og Bygningsvaesen, Ugeoversigt *(Denmark)*
***Inorg. Chim. Acta***
Inorganica Chimica Acta *(Italy)*
***Inst. Mining Met., Trans./Sect. B***
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*
***Inst. Petrol. Rev.***
Institute of Petroleum Review, The *(England)*
***Instrum. Contr. Eng.***
Instrument and Control Engineering *(England)*
***Instrum. Med.***
Instrumentation in Medicine *(England)*
***Int. Ass. Sci. Hydrol., Bull.***
International Association of Scientific Hydrology, Bulletin *(Belgium)*
***Int. Chem. Eng.***
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*
***Int. Dig. Health Legislation***
International Digest of Health Legislation *(Switzerland)*
***Int. J. Mass Spectrom. Ion Phys.***
International Journal of Mass Spectrometry and Ion Physics
*see J. Mass Spectrom. Ion Phys.*
***Int. J. Neurol.***
International Journal of Neurology *(U. S.)*
***Int. J. Theor. Phys.***
International Journal of Theoretical Physics *(England)*
***Int. Rev. Gesam. Hydrobiol.***
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*
***Int. Surg.***
International Surgery *(U. S.)*
***Inzh. Zh., Mekh. Tverd. Tela***
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly Inzhenernyi Zhurnal) *(U.S.S.R.)*
***Iron Age Metalwork. Int.***
Iron Age Metalworking International *(U. S.)*
***ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp.***
ISA (Instrument Society of America), Proceedings, National Power Instrumentation Symposium *(U. S.)*
***Issled. Genet.***
Issledovaniya po Genetike *(U.S.S.R.)*
***Issled. Primen. Tsifrovykh Analogovykh Vychisl. Mash. Yad. Fiz. Tekh., Sb. Statei (U.S.S.R.)***
*Issledovanie Primenenii Tsifrovykh i Analogovykh Vychislitel'nykh Mashin v Yadernoi Fizike i Tekhnike, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*
***Izobret., Prom. Obraztsy, Tovarnye Znaki***
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*
***Izv. Akad. Nauk Arm. SSR, Biol. Nauki***
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki (superseded by Biologicheskii Zhurnal Armenii) *(Armenian S.S.R.)*
***Izv. Akad. Nauk Arm. SSR, Khim. Nauki***
Izvestiya Akademii Nauk Armyanskoi SSR, Khimicheskie Nauki *(Armenian S.S.R.)*
***Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk***
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*
***Izv. Akad. Nauk Arm. SSR, Ser. Tekh. Nauk***

Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Tekhnicheskikh Nauk *(Armenian S.S.R.)*

**Izv. Akad. Nauk Kaz. SSR, Ser. Khim.**
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Khimicheskaya *(Kazakh S.S.R.)*

**Izv. Akad. Nauk SSSR, Otd. Takh. Nauk, Mekh. Mashinostr.**
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie *(U.S.S.R.)*

**Izv. Akad. Nauk SSSR, Ser. Biol.**
Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

**Izv. Akad. Nauk SSSR, Ser. Geol.**
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*

**Izv. Akad. Nauk SSSR, Ser. Mat.**
Izvestiya Akademii Nauk SSSR, Seriya Matematicheskaya *(U.S.S.R.)*

**Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Takh. Khim. Nauk**
Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Fiziko-Tekhnicheskikh i Khimicheskikh Nauk *(Tadzhik S.S.R.)*

**Izv. Akad. Nauk Uzb. SSR, Ser. Takh. Nauk**
Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Tekhnicheskikh Nauk *(Uzbek S.S.R.)*

**Izv. Gl. Astron. Observ. Pulkove**
Izvestiya Glavnoi Astronomicheskoi Observatorii v Pulkove *(U.S.S.R.)*

**Izv. Inst. Elektron., Bulg. Akad. Nauk.**
Izvestiya na Instituta po Elektronika, Bulgarska Akademiya na Naukite *(Bulgaria)*

**Izv. Inst. Khidrol. Meteorol., Bulg. Akad. Nauk.**
Izvestiya na Institutapo Khidrologiya i Meteorologiya, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*

**Izv. Timiryazev. Sel'skokhoz. Akad.**
Izvestiya Timiryazevskoi Sel'skokhozyaistvennoi Akademii *(U.S.S.R.)*

**Izv. Vost. Filial. Akad. Nauk SSSR**
Izvestiya Vostochniykh Filialov Akademii Nauk SSSR *(U.S.S.R.)*

**Izv. Vyssh. Ucheb. Zaved., Mat.**
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

**Izv. Vyssh. Ucheb. Zaved., Priborostr.**
Izvestiya Vysshikh Uchebnykh Zavedenii, Priborostroenie *(U.S.S.R.)*

**Izv. Vyssh. Ucheb. Zaved., Tekhnol. Legk. Prom.**
Izvestiya Vysshikh Uchebnykh Zavedenii, Tekhnologiya Legkoi Promyshlennosti *(Ukrainian S.S.R.)*

**J. Amer. Podiat. Ass.**
Journal of the American Podiatry Association *(U. S.)*

**J. Amer. Soc. Safety Eng.**
Journal of the American Society of Safety Engineers *(U. S.)*

**Jap. J. Anesthesiol.**
Japanese Journal of Anesthesiology, The
*see Masui*

**Jap. J. Dairy Sci.**
Japanese Journal of Dairy Science (Japan)
*see Rakuno Kagaku no Kenkyu*

**Jap. J. Exp. Morphol.**
Japanese Journal of Experimental Morphology
*see Jikken Kaitaigakushi*

**Jap. J. Genet., Suppl.**
Japanese Journal of Genetics, Supplement
*see Idengaku Zasshi, Suppl.*

**Jap. J. Hum. Genet.**
Japanese Journal of Human Genetics, The
*see Jinrui Idengaku Zasshi*

**Jap. J. Ophthalmol.**
Japanese Journal of Ophthalmology *(Japan)*

**Jap. J. Pharm. Chem.**
Japanese Journal of Pharmacy and Chemistry
*see Yakugaku Kenkyu*

**Jap. J. Zootech. Sci.**
Japanese Journal of Zootechnical Science
*see Nippon Chikusangaku Kaiho*

**JARE Sci. Rep., Spec. Issue**
JARE Scientific Reports, Special Issue *(Japan)*

**J. Ass. Phys. Ment. Rehabil.**
Journal of the Association for Physical and Mental Rehabilitation *(U. S.)*

**J. Ass. Public Anal.**
Journal of the Association of Public Analysts *(England)*

**J. Aust. Ceram. Soc.**
Journal of the Australian Ceramic Society *(Australia)*

**J. Balneol. Soc. Jap.**
Journal of the Balneological Society of Japan
*see Onsen Kagaku*

**J. Belge Radiol., Monogr.**
*Journal Belge de Radiologie, Monographie *(Belgium)*

**J. Biol. Photogr. Ass.**
Journal of the Biological Photographic Association, The *(U. S.)*

**J. Brit. Ceram. Soc.**
Journal of the British Ceramic Society, The *(England)*

**J. Cell Sci.**
*Journal of Cell Science *(England)*

**J. Chiba Med. Soc.**
Journal of Chiba Medical Society, The
*see Chiba Igakkai Zasshi*

**J. Chin. Silicates Soc.**
Journal of the Chinese Silicates Society
*see Kuei Suan Yen Hsueh Poo*

**J. Comb. Theory**
Journal of Combinatorial Theory *(U. S.-England)*

**J. Cons. Perma. Int. Explor. Mer**
Journal du Conseil, Conseil Permanent International pour l'Exploration de la Mer *(Denmark)*

**J. Cryst. Growth**
Journal of Crystal Growth *(Netherlands)*

**J. Curr. Laser Abstr.**
Journal of Current Laser Abstracts *(Canada)*

**J. Earth Sci., Nagoya Univ.**
*Journal of Earth Sciences, Nagoya University, The *(Japan)*

**J. Ecol.**
Journal of Ecology *(England)*

**J. Egypt. Public Health Ass.**
Journal of the Egyptian Public Health Association *(Egypt)*

**Jemna Mech. Opt.**
Jemna Mechanika a Optika *(Czechoslovakia)*

**Jeune Sci.**
Jeune Scientifique *(Canada)*

**J. Food Hyg. Soc. Jap.**
Journal of the Food Hygienic Society of Japan
*see Shokuhin Eiseigaku Zasshi*

**J. Food Sci. Technol.**
Journal of Food Science and Technology
*see Nippon Shokuhin Kogyo Gakkaishi*

**J. Forensic Med.**
Journal of Forensic Medicine *(South Africa)*

**J. Formosan Med. Ass.**
Journal of the Formosan Medical Association
*see T'ai-wan I Hsueh Hui Tsa Chih*

**J. Fuel Heat. Technol.**
Journal of Fuel and Heating Technology *(England)*

**J. Geol.**
Journal of Geology *(U. S.)*

**J. High Polym. (Shanghai)**
Journal of High Polymers (Shanghai)
*see Kao Fen Tzu T'ung Hsun*

**Jibiinkoka Rinsho**
Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*

**Jikken Kaitaigakushi**
Jikken Kaitaigakushi (Japanese Journal of Experimental Morphology) *(Japan)*

**J. Indian Soc. Soil Sci.**
Journal of the Indian Society of Soil Science *(India)*

**Jinrui Idengaku Zasshi**
Jinrui Idengaku Zasshi (The Japanese Journal of Human Genetics) *(Japan)*

**J. Inst. Safety High Pressure Gas Eng.**
Journal of the Inst. of Safety of High Pressure Gas Engineering
*see Koatsu Gasu*

**J. Inst. Telecommun. Eng.**
Journal of the Institution of Telecommunication Engineers *(India)*

**J. Irish Med. Ass.**
Journal of the Irish Medical Association *(Ireland)*

**J. Irrig. Drain. Div., Amer. Soc. Civil Eng.**
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

**J. Jap. Ass. Phys. Med., Balneol., Climatol.**
Journal of the Japanese Association of Physical Medicine, Balneology, and Climatology, The
*see Nippon Onsen Kiko Butsuri Igakkai Zasshi*

**J. Jap. Health Phys. Soc.**
Journal of Japan Health Physics Society
*see Hoken Butsuri*

**J. Jap. Med. Ass.**
Journal of the Japan Medical Association, The
*see Nippon Ishikai Zasshi*

**J. Jap. Petrol. Inst.**
Journal of the Japan Petroleum Institute

see **Sekiyu Gakkaishi**

**J. Jap. Soc. Food Nutr.**
Journal of Japanese Society of Food and Nutrition
see **Eiyo To Shokuryo**

**J. Jap. Soc. Hort. Sci.**
Journal of the Japanese Society for Horticultural Science
see **Engei Gakkai Zasshi**

**J. Jap. Stomatol. Soc.**
Journal of the Japan Stomatological Society, The
see **Kokubyo Gakkai Zasshi**

**J. Jap. Tech. Ass. Pulp Pap. Ind.**
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi

**J. Jap. Wood Res. Soc.**
Journal of the Japan Wood Research Society
see **Mokuzai Gakkaishi**

**J. Karnatak Univ.**
Journal of the Karnatak University *(India)*

**J. Kyoto Prefect. Med. Univ.**
Journal of Kyoto Prefectural Medical University
see **Kyoto Furitsu Ika Daigaku Zasshi**

**J. Macromol. Sci., Part A**
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*

**J. Maine Med. Ass.**
Journal of the Maine Medical Association *(U. S.)*

**J. Marine Res.**
Journal of Marine Research (Sears Foundation for Marine Research) *(U.S.)*

**J. Mass Spectrom. Ion Phys.**
*Journal of Mass Spectrometry and Ion Physics *(Netherlands)*

**J. Med. Soc. N. J.**
Journal of the Medical Society of New Jersey *(U. S.)*

**J. Metal Finish. Soc. Jap.**
Journal of the Metal Finishing Society of Japan, The
see **Kinzoku Hyomen Gijutsu**

**J. Mol. Struct.**
*Journal of Molecular Structure *(Netherlands)*

**J. Nagasaki Med. Ass., Suppl.**
Journal of the Nagasaki Medical Association, Supplement
see **Nagasaki Igakkai Zasshi, Suppl.**

**J. Neurol. Sci.**
Journal of the Neurological Sciences *(Netherlands)*

**J. Nucl. Med., Suppl.**
*Journal of Nuclear Medicine, Supplement *(U.S.)*

**J. Nucl. Sci. (Seoul)**
*Journal of Nuclear Sciences (Seoul) (Wonjaryogwon. Yon'gu Nonmun Chip) *(South Korea)*

**J. Obstet. Gynaecol. India**
Journal of Obstetrics and Gynaecology of India *(India)*

**J. Optimization Theory Appl.**
Journal of Optimization Theory and Applications *(U. S.)*

**J. Oral Surg.**
Journal of Oral Surgery *(U. S.)*

**J. Osaka Univ. Dent. Soc.**
Journal of the Osaka University Dental Society, The
see **Osaka Daigaku Shigaku Zasshi**

**J. Otolaryngol. Soc. Aust.**
Journal of the Otolaryngological Society of Australia *(Australia)*

**J. Paleontol.**
Journal of Paleontology *(U.S.)*

**J. Phys., A (London)**
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

**J. Phys., B (London)**
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

**J. Phys., C (London)**
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

**J. Phys., E (London)**
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

**J. Phys. Chem. Solids, Suppl.**
*Journal of Physics and Chemistry of Solids, Supplement *(England)*

**J. Physiol. Soc. Jap.**
Journal of the Physiological Society of Japan
see **Nippon Seirigaku Zasshi**

**J. Phys. Soc. Jap., Suppl.**
*Journal of the Physical Society of Japan, Supplement *(Japan)*

**J. Proc. Inst. Chem. (India)**
Journal and Proceedings of the Institution of Chemists (India) *(India)*

**J. Radioanal. Chem.**
*Journal of Radioanalytical Chemistry *(Netherlands–Hungary)*

**J. Radiol. Phys. Ther., Univ. Kanazawa**
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see **Kanazawa Irigaku Sosho**

**J. Roy. Army Med. Corps**
Journal of the Royal Army Medical Corps *(England)*

**J. Sediment. Petrol.**
Journal of Sedimentary Petrology *(U. S.)*

**J. Soc. Eng. Miner. Springs, Jap.**
Journal of the Society of Engineers for Mineral Springs, Japan
see **Onsen Kogakkaishi**

**J. Soc. Fiber Sci. Technol., Jap.**
Journal of the Society of Fiber Science and Technology, Japan
see **Sen'i Gakkaishi**

**J. Soc. Instrum. Contr. Eng.**
Journal of the Society of Instrument and Control Engineers
see **Keisoku To Seigyo**

**J. Soc. Leather Trades Chem.**
Journal of the Society of Leather Trades Chemists *(England)*

**J. Soc. Rubber Ind., Jap.**
Journal of the Society of Rubber Industry, Japan
see **Nippon Gomu Kyokaishi**

**J. Soc. Sci. Photogr. Jap.**
Journal of the Society of Scientific Photography of Japan, The
see **Nippon Shashin Gakkai Kaishi**

**J. Tenn. Med. Ass.**
Journal of the Tennessee Medical Association *(U. S.)*

**J. Tokyo Women's Med. Coll.**
Journal of Tokyo Women's Medical College
see **Tokyo Joshi Ika Daigaku Zasshi**

**Jugoslov. Pronalazastvo**
Jugoslovensko Pronalazastvo *(Yugoslavia)*

**Kagaku Keisatsu Kenkyusho Hokoku**
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

**Kagaku Kogaku**
*Kagaku Kogaku (Chemical Engineering, Japan) *(Japan)*

**Kagoshima Daigaku Suisangakubu Kiyo**
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*

**Kaibogaku Zasshi**
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*

**Kali Steinsalz**
Kali und Steinsalz *(West Germany)*

**Kami Pa Gikyoshi**
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*

**Kanazawa Daigaku Kekkaku Kenkyusho Nenpo**
*Kanazawa Daigaku Kekkaku Kenkyusho Nenpo (Annual Report of the Research Inst. of Tuberculosis, Kanazawa University) *(Japan)*

**Kanazawa Irigaku Sosho**
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*

**Kao Fen Tzu T'ung Hsun**
Kao Fen Tzu T'ung Hsun (Journal of High Polymers) *(China)*

**Keisoku To Seigyo**
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

**Kenchiku Gijutsu**
Kenchiku Gijutsu (Building Engineering) *(Japan)*

**Kernenergie, Beil.**
*Kernenergie, Beilage *(East Germany)*

**Kinzoku Hyomen Gijutsu**
Kinzoku Hyomen Gijutsu (The Journal of the Metal Finishing Society of Japan) *(Japan)*

**Kitakanto Igaku**
*Kitakanto Igaku (Kitakanto Medical Journal) *(Japan)*

**Kitakanto Med. J.**
Kitakanto Medical Journal
see **Kitakanto Igaku**

**Kleinheubacher Ber.**
Kleinheubacher Berichte *(East Germany)*

**Klepzig Fachber.**
Klepzig Fachberichte fuer die Fuehrungskraefte aus Maschinenbau und Huettenwesen (formerly Klepzigs Anzeiger fuer die Berg-, Huetten-, Metall- und Maschinenindustrie) *(West Germany)*

**Klin. Monatsbl. Augenheilk.**
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*

**Koatsu Gasu**
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*

**Kobe Kogyo Giho**
Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*

**Kobe Kogyo Tech. Rep.**
Kobe Kogyo Technical Report
*see Kobe Kogyo Giho*

**K'o Hsueh Tz Chung**
K'o Hsueh Tz Chung (Popular Science) *(China)*

**Kokubyo Gakkai Zasshi**
Kokubyo Gakkai Zasshi (Journal of the Japan Stomatological Society, The) *(Japan)*

**Konkurito Jonaru**
Konkurito Jonaru (Concrete Journal) *(Japan)*

**Konserv. Ovoshchesush. Prom.**
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*

**Konzerv- Paprikaipar**
Konzerv- es Paprikaipar *(Hungary)*

**Korroz. Metal. Splavov**
Korroziya Metallov i Splavo *(U.S.S.R.)*

**Kosm. Biol. Med.**
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*

**Kosm. Luchi**
Kosmicheskie Luchi *(U.S.S.R.)*

**Kovove Mater.**
Kovove Materialy *(Czechoslovakia)*

**Kowan Giken Shiryo**
Kowan Giken Shiryo (Technical Note of Port and Harbour Technical Research Inst., Ministry of Transportation, Japan) *(Japan)*

**Krist. Tech.**
Kritstall und Technik *(East Germany)*

**Kuei Suan Yen Hsueh Pao**
Kuei Suan Yen Hsueh Pao (Journal of the Chinese Silicates Society) *(China)*

**Kuki Seijo**
Kuki Seijo (Air Cleaning) *(Japan)*

**Kumamoto Daigaku Kogakubu Kenkyu Hokoku**
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*

**Kumamoto Daigaku Kyoikugakubu Kiyo**
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*

**Kurznachr. Akad. Wiss. Goettingen**
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*

**Kyosai Iho**
*Kyosai Iho (Medical Journal of Mutual Aid Association) *(Japan)*

**Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku**
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*

**Kyoto Furitsu Ika Daigaku Zasshi**
*Kyoto Furitsu Ika Daigaku Zasshi (Journal of Kyoto Prefectural Medical University) *(Japan)*

**Kyushu Daigaku Kogaku Shuho**
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*

**Kyushu Daigaku Nogakubu Gakugei Zasshi**
*Kyushu Daigaku Nogakubu Gakugei Zasshi (Science Bulletin of the Faculty of Agriculture, Kyushu University) *(Japan)*

**Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku**
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*

**Lahey Clin. Found. Bull.**
Lahey Clinic Foundation Bulletin (formerly Lahey Clinic Bulletin) *(U. S.)*

**Lakokrasoch. Mater. Ikh Primen.**
Lakokrasochnye Materialy i Ikh Primenenie *(U.S.S.R.)*

**Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh**
Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (The Lanchow University Journal, The Natural Sciences) *(China)*

**Lanchow Univ. J., Natur. Sci.**
Lanchow University Journal, The, The Natural Sciences
*see Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh*

**Landarzt**
Landarzt *(West Germany)*

**Landbouwtijdschrift**
Landbouwtijdschrift *(Belgium)*

**Lasers Opt. Non Conv.**
Lasers et Optique Non Conventionelle *(France)*

**Lav. Med.**
Lavoro e Medicina *(Italy)*

**Lebensversicherungsmedizin**
Lebensversicherungsmedizin *(West Germany)*

**Light Metal Age**
Light Metal Age *(U. S.)*

**Light Metals**
Light Metals (superseded by Light Metals and Metals Industry (London)) *(England)*

**Light Metals Metal Ind. (London)**
*Light Metals and Metal Industry (London) (formed by merger of Light Metals and The Metal Industry (London)) *(England)*

**Lipids**
Lipids *(U. S.)*

**Liteinoe Proizvod.**
Liteinoe Proizvodstvo *(U.S.S.R.)*

**Lithos**
Lithos *(Norway)*

**Lutte Cancer**
Lutte Contre le Cancer *(France)*

**Machinery (N. Y.)**
Machinery (New York) *(U. S.)*

**Mach. Prod. Eng.**
Machinery and Production Engineering *(England)*

**Mach. Shop Eng. Mfg.**
Machine Shop and Engineering Manufacture *(England)*

**Mach. Tool Blue Book**
Machine and Tool Blue Book *(U. S.)*

**Mag. Stand.**
Magazine of Standards *(U. S.)*

**Magy. Traumatol., Orthop. Helyreallito Sebesz.**
Magyar Traumatologia, Orthopaedia es Helyreallito Sebeszet *(Hungary)*

**Manage. Sci.**
Management Science *(U.S.)*

**Mar. Eng.**
Marine Engineering
*see Fune No Kagaku*

**Mashinovedenie**
Mashinovedenie *(U.S.S.R.)*

**Mass Prod.**
Mass Production *(England)*

**Masui**
*Masui (The Japanese Journal of Anesthesiology) *(Japan)*

**Mater. Res. Bull.**
Materials Research Bulletin *(U. S.)*

**Meas. Instrum. Rev.**
Measurement and Instrument Review *(England)*

**Mech. World Eng. Rec.**
*Mechanical World and Engineering Record *(England)*

**Med. Bull. U. S. Army, Eur.**
Medical Bulletin of the U. S. Army, Europe *(U.S.)*

**Meded. Kon. Vlaam. Acad. Wetensch. Belg., Kl. Wetensch.**
Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren on Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*

**Med. J. Mutual Aid Ass.**
Medical Journal of Mutual Aid Association
*see Kyosai Iho*

**Med.-Markt/Acta Medicotech.**
Medizinal-Markt/Acta Medicotechnica *(Germany)*

**Med. Nucl.-Radiobiol. Lat., Suppl.**
*Medicina Nucleare–Radiobiologica Latina, Suppl. *(Italy)*

**Med. Prom. SSSR**
Meditsinskaya Promyshlennost SSSR *(U.S.S.R)*

**Med. Radiol. (USSR) (Engl. Transl.)**
Medical Radiology (USSR) (English Translation of Meditsinskaya Radiologiya) *(U. S.)*

**Mekh. Elek. Sots. Sel. Khoz.**
Mekhanizatsiya i Elektrifikatsiya Sotsialisticheskogo Sel'skogo Khozyaistva *(U.S.S.R.)*

**Mekh. Polim.**
Mekhanika Polimerov *(Latvian S.S.R.)*

**Mekh. Razrusheniya Metal., Akad. Nauk Ukr. SSR, Respub. Mezhvedom. Sb.**
Mekhanizm Razrusheniya Metallov, Akademiya Nauk Ukrainskoi SSR, Respublikanskii Mezhvedomstvennyi Sbornik *(Ukrainian S.S.R.)*

**Mem. Fac. Educ., Kumamoto Univ.**
Memoirs of the Faculty of Education, Kumamoto University
*see Kumamoto Daigaku Kyoikugakubu Kiyo*

**Mem. Fac. Fish., Kagoshima Univ.**
Memoirs of the Faculty of Fisheries, Kagoshima University
*see Kagoshima Daigaku Suisangakubu Kiyo*

**Mem. Fac. Sci., Kyoto Univ., Ser. Biol.**
Memoirs of the Faculty of Science, Kyoto University, Series of

Biology (formerly Memoirs of the College of Science, University of Kyoto, Series B (Biology)) *(Japan)*

**Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem.**
Memoirs of the Faculty of Science, Kyoto University, Series of Physics, Astrophysics, Geophysics, and Chemistry (formerly Memoirs of the College of Science, University of Kyoto, Series A) *(Japan)*

**Mem. Hyogo Univ. Agr.**
Memoirs of the Hyogo University of Agriculture
*see Hyogo Noka Daigaku Kiyo*

**Meres Automat.**
Meres es Automatika *(Hungary)*

**Mes., Regul., Automat.**
Mesures, Regulation, Automatisme *(France)*

**Messtechnik**
*Messtechnik. Zeitschrift fuer Instrumentenkunde (supersedes Zeitschrift fuer Instrumentenkunde) *(West Germany)*

**Mes.-Steuern-Regeln**
Messen-Steuern-Regeln *(East Germany)*

**Metabolism**
*Metabolism: Clinical and Experimental *(U. S.)*

**Metal Finish.**
Metal Finishing *(U. S.)*

**Metallwirtschaft**
Metallwirtschaft–Wissenschaft–Technik *(Germany)*

**Metals (London)**
Metals (London) *(England)*

**Metals Abstr.**
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*

**Metal Sci. Heat Treat. (USSR) (Engl. Transl.)**
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*

**Metal Treat.**
Metal Treating *(U. S.)*

**Metalurgia (Sao Paulo)**
Metalurgia (Sao Paulo) *(Brazil)*

**Met. Elec. (Madrid)**
Metalurgia y Electricidad (Madrid) *(Spain)*

**Meteoritika**
Meteoritika *(U.S.S.R.)*

**Method. Phys. Anal.**
Methodes Physiques d'Analyse *(France)*

**Meth. Phys. Anal.**
Methodes Physiques d'Analyse *(France)*

**Met. Rev. (Publ. in Metals Mater.)**
Metallurgical Reviews (Published in Metals and Materials) *(England)*

**Met. Spec. (Paris)**
Metallurgie Speciale (Paris) *(France)*

**Microwaves**
Microwaves *(U. S.)*

**Mie Kaiho Gyosekishu**
Mie Kaiho Gyosekishu *(Japan)*

**Milk Dealer**
Milk Dealer, The *(U. S.)*

**Miner. Deposita**
Mineralium Deposita *(West Germany)*

**Minerva Med. Giuliana**
*Minerva Medica Giuliana. Supplemento a Minerva Medica *(Italy)*

**Minerva Med. Sicil.**
*Minerva Medica Siciliana (continuation of Gazzetta Medica Siciliana) Supplemento a Minerva Medica *(Italy)*

**Minerva Med., Suppl.**
*Minerva Medica, Supplemento *(Italy)*

**Minerva Radiol.**
*Minerva Radiologica (formerly Minerva Radiologica, Fisioterapica e Radiobiologica) *(Italy)*

**Mines Met.**
Mines et Metallurgie *(France)*

**Mining Congr. J.**
Mining Congress Journal *(U. S.)*

**Mining Met. Quart. (USSR) (Engl. Transl.)**
Mining and Metallurgy Quarterly (USSR) (English Translation of Rudarsko-Metalurski Zbornik) *(Yugoslavia)*

**Mining Met. Quart. (USSR) (Engl. Transl.), Suppl.**
Mining and Metallurgy Quarterly, (USSR) (English Translation of Rudarsko-Metalurski Zbornik, Supplement) *(Yugoslavia)*

**Missili Spazio**
Missili e Spazio *(Italy)*

**Mod. Packag.**
Modern Packaging *(U. S.)*

**Mod. Unfallverhuet.**
Moderne Unfallverhuetung *(West Germany)*

**Mokuzai Gakkaishi**
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*

**Mol. Biol.**
*Molekulyarnaya Biologiya *(U.S.S.R.)*

**Molk.-Ztg. Welt Milch**
Molkerei-Zeitung Welt der Milch *(West Germany)*

**Mon. Corresp. Beforderd. Erd Himmelskunde**
Monatliche Correspondenz zur Beforderung der Erd und Himmelskunde *(East Germany)*

**Monit. Zool. Ital., Suppl.**
Monitore Zoologico Italiano, Supplemento *(Italy)*

**Monogr. Nucl. Med. Biol.**
Monographs on Nuclear Medicine and Biology *(Netherlands)*

**Montes**
Montes *(Spain)*

**Motor Ship**
Motor Ship *(England)*

**Motortech. Z.**
Motortechnische Zeitschrift *(West Germany)*

**Muanyag Gumi**
Muanyag es Gumi *(Hungary)*

**Nachrichtentech. Fachber.**
Nachrichtentechnische Fachberichte *(West Germany)*

**Nachrichtentechnik**
Nachrichtentechnik *(East Germany)*

**Nagano Kogyo Koto Senmon Gakko Kiyo**
Nagano Kogyo Koto Senmon Gakko Kiyo (Research Reports, Nagano Technical College) *(Japan)*

**Nagasaki Igakkai Zasshi, Suppl.**
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*

**Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh**
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Universitatis Nankinensis Scientiarum Naturalium) *(China)*

**Nat. Fire Codes**
National Fire Codes *(U. S.)*

**Nat. Med. J. China**
National Medical Journal of China
*see Chung Hua I Hsueh Tsa Chih*

**Natur. Appl. Sci. Bull.**
Natural and Applied Science Bulletin *(Philippines)*

**Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.**
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukroninskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*

**Neftegazov. Geol. Geofiz.**
Neftegazovaya Geologiya i Geofizika *(U.S.S.R.)*

**Nerv. Sist., Leningrad. Gos. Univ., Fiziol. Inst.**
Nervnaya Sistema, Leningradskii Gosudarstvennyi Universitet imeni A. A. Zhdanova, Fiziologicheskii Institut *(U.S.S.R.)*

**Neth. J. Sea Res.**
Netherlands Journal of Sea Research *(Netherlands)*

**Neues Jahrb. Mineral., Monatsh.**
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*

**Newslett. Isotop. Generator Inform. Centre**
*Newsletter of the Isotopic Generator Information Centre *(France)*

**Nippon Byori Gakkai Kaishi**
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*

**Nippon Chikusangaku Kaiho**
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*

**Nippon Geka Hokan**
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*

**Nippon Gomu Kyokaishi**
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*

**Nippon Ishikai Zasshi**
Nippon Ishikai Zasshi (The Journal of the Japan Medical Association) *(Japan)*

**Nippon Kaisui Gakkaishi**
Nippon Kaisui Gakkaishi (Bulletin of the Society of Sea Water Science, Japan) *(Japan)*

**Nippon No Kagaku To Gijutsu**
Nippon No Kagaku To Gijutsu (Science and Technology of Japan) *(Japan)*

**Nippon Onsen Kiko Butsuri Igakkai Zasshi**
*Nippon Onsen Kiko Butsuri Igakkai Zasshi (The Journal of the Japanese Association of Physical Medicine, Balneology, and Climatology) *(Japan)*

**Nippon Sakumotsu Gakkai Kiji**

Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*

***Nippon Seirigaku Zasshi***
*Nippon Seirigaku Zasshi (Journal of the Physiological Society of Japan) *(Japan)*

***Nippon Shashin Gakkai Kaishi***
*Nippon Shashin Gakkai Kaishi (The Journal of the Society of Scientific Photography of Japan) *(Japan)*

***Nippon Shokubutsu Byori Gakkaiho***
*Nippon Shokubutsu Byori Gakkaiho (Annals of the Phytopathological Society of Japan) *(Japan)*

***Nippon Shokuhin Kogyo Gakkaishi***
Nippon Shokuhin Kogyo Gakkaishi (Journal of Food Science and Technology) *(Japan)*

***Nippon Shonika Gakkai Zasshi***
*Nippon Shonika Gakkai Zasshi (Acta Paediatrica Japonica) *(Japan)*

***Nippon Yakurigaku Zasshi***
*Nippon Yakurigaku Zasshi (Folia Pharmacologica Japonica) *(Japan)*

***Nisshin Seiko Giho***
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*

***Nogyo Oyobi Engei***
*Nogyo Oyobi Engei (Agriculture and Horticulture) *(Japan)*

***Nord. Med.***
Nordisk Medicin *(Sweden)*

***Norsk Skogind.***
Norsk Skogindustri *(Norway)*

***Nucl. India***
Nuclear India *(India)*

***Nucl. Law Bull.***
*Nuclear Law Bulletin *(Belgium)*

***Nucl. Law Bull., Suppl.***
*Nuclear Law Bulletin, Supplement *(Belgium)*

***Nukleonika, Supl.***
*Nukleonika, Suplement *(Poland)*

***N. Z. Dent. J.***
New Zealand Dental Journal *(New Zealand)*

***N. Z. J. Agr.***
New Zealand Journal of Agriculture *(New Zealand)*

***N. Z. Med. J., Suppl.***
New Zealand Medical Journal, Supplement *(New Zealand)*

***N. Z. Sci. Rev.***
New Zealand Science Review *(New Zealand)*

***Oceanogr. Mag.***
Oceanographical Magazine, The *(Japan)*

***Ochr. Pr.***
Ochrona Pracy *(Poland)*

***Odontol. Tidskr.***
Odontologisk Tidskrift *(Sweden)*

***Oftal'mol. Zh.***
Oftal'mologicheskii Zhurnal *(Ukrainian S.S.R.)*

***Ohio State Med. J.***
Ohio State Medical Journal *(U. S.)*

***Okajimas Folia Anat. Jap.***
*Okajimas Folia Anatomica Japonica *(Japan)*

***Okayama Daigaku Onsen Kenkyusho Hokoku***
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*

***Oncol. Radiol.***
Oncologia si Radiologia *(Romania)*

***Onde Elec., Suppl.***
*Onde Electrique, L, Supplement *(France)*

***Onsen Kagaku***
Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*

***Onsen Kogakkaishi***
Onsen Kogakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*

***Opt.-Mekh. Prom.***
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*

***Osaka Daigaku Shigaku Zasshi***
Osaka Daigaku Shigaku Zasshi (The Journal of Osaka University Dental Society) *(Japan)*

***Osaka Furitsu Kogyo Shoreikan Hokoku***
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*

***Osaka Kogyo Gijutsu Shikensho Kiho***
Osaka Kogyo Gijutsu Shikensho Kiho (Bulletin of the Government Industrial Research Institute, Osaka) *(Japan)*

***Osaka Shiritsu Kogyo Kenkyusho Hokoku***
*Osaka Shiritsu Kogyo Kenkyusho Hokoku (Bulletin of the Osaka Municipal Technical Research Inst.) *(Japan)*

***Oto-Rhino-Laryngol. Clin.***
Oto-Rhino-Laryngological Clinic
**see *Jibiinkoka Rinsho***

***Palaeogeogr., Palaeoclimatol., Palaeoecol.***
Palaeogeography, Palaeoclimatology, Palaeoecology *(Netherlands)*

***Paperboard Packag.***
Paperboard Packaging *(U. S.)*

***Paperi Puu-Lehdesta***
Paperi ja Puu-Lehdesta *(Finland)*

***Pap. Inst. Thermal Spring Res., Okayama Univ.***
Papers of the Inst. for Thermal Spring Research, Okayama University
**see *Okayama Daigaku Onsen Kenkyusho Hokoku***

***Pediatrics, Suppl.***
Pediatrics, Supplement *(U. S.)*

***Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh***
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*

***Petrol Gaze***
*Petrol si Gaze *(Romania)*

***Photogr. Appl. Sci. Technol.***
*Photographic Applications in Science and Technology *(U. S.)*

***Phys. Bull. (London)***
Physics Bulletin (London) *(England)*

***Phys.-Diaet. Ther.***
Physikalisch-Diaetetische Therapie *(West Germany)*

***Phys. Earth Planet. Interiors***
*Physics of the Earth and Planetary Interiors *(Netherlands)*

***Pipes Pipelines Int.***
Pipes and Pipelines International (formerly International Pipes and Pipelines) *(England)*

***Piping Eng.***
Piping Engineering, The
**see *Haikan Gijutsu***

***Plant Breed. Abstr.***
*Plant Breeding Abstracts *(England)*

***Plant Cell Physiol. (Kyoto)***
Plant and Cell Physiology (Kyoto) *(Japan)*

***Plant Physiol., Suppl.***
*Plant Physiology, Supplement *(U. S.)*

***Plastics (London)***
*Plastics (London) *(England)*

***Poluprov. Prib. Ikh Primen., Sb. Statei***
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*

***Pop. Sci. (Peking)***
Popular Science (Peking)
**see *K'o Hsueh Tu Chung***

***Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.***
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*

***Praxis (Bern)***
Praxis (Bern) *(Switzerland)*

***Probl. Fiziol. Opt.***
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*

***Proc. Amer. Soc. Hort. Sci.***
Proceedings of the American Society for Horticultural Science *(U. S.)*

***Proc. Astron. Soc. Aust.***
Proceedings of the Astronomical Society of Australia *(Australia)*

***Proc. Crop Sci. Soc. Jap.***
Proceedings of the Crop Science Society of Japan
**see *Nippon Sakumotsu Gakkai Kiji***

***Proc. Egypt. Acad. Sci.***
Proceedings of the Egyptian Academy of Sciences *(Egypt)*

***Prochnost Din. Aviats. Dvigatelei***
Prochnost i Dinamika Aviatsionnykh Dvigatelei *(U.S.S.R.)*

***Proc. Indian Acad. Sci., Sect. B***
Proceedings of the Indian Academy of Sciences, Section B *(India)*

***Proc. La. Acad. Sci.***
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*

***Proc. Nat. Acad. Sci., India, Sect. A***
Proceedings of the National Academy of Sciences, India, Section A *(India)*

***Proc. Phys. Soc. (London)***
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*

***Proc. Soc. Water Treat. Exam.***
Proceedings of the Society for Water Treatment and Examination *(England)*

***Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)***
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*

***Prod. Eng.***
Product Engineering *(U. S.)*
***Prod. Pharm.***
Produits Pharmaceutiques *(France)*
***Progr. Anal. Chem.***
Progress in Analytical Chemistry *(U. S.)*
***Progr. High Temp. Phys. Chem.***
Progress in High Temperature Physics and Chemistry *(England)*
***Progr. Ind. Microbiol.***
Progress in Industrial Microbiology *(U. S.–England)*
***Progr. Nucl. Tech. Instrum.***
Progress in Nuclear Techniques and Instrumentation *(Netherlands)*
***Progr. Solid State Chem.***
Progress in Solid State Chemistry *(England)*
***Progr. Stiintei***
Progresele Stiintei *(Romania)*
***Prot. Civ. Secur. Ind.***
Protection Civile et Securite Industrielle *(France)*
***Protein, Nucl. Acid, Enzyme***
Protein, Nucleic Acid, Enzyme
*see* ***Tanpakushitsu Kakusan Koso***
***Prum. Potravin***
Prumysl Potravin *(Czechoslovakia)*
***Przegl. Lek.***
Przeglad Lekarski *(Poland)*
***Przegl. Morski***
Przeglad Morski *(Poland)*
***PTB Mitt.***
*PTB Mitteilungen. Amts- und Mitteilungsblatt der Physikalisch-Technischen Bundesanstalt *(West Germany)*
***Pubb. Centro Sper. Agr. Forest.***
Pubblicazioni del Centro di Sperimentazione Agricola e Forestale *(Italy)*
***Quad. Nutr.***
Quaderni della Nutrizione *(Italy)*
***Quart. Colo. Sch. Mines***
Quarterly of the Colorado School of Mines *(U. S.)*
***Queensland Govt. Mining J.***
Queensland Government Mining Journal *(Australia)*
***Radiat. Res. Rev.***
Radiation Research Reviews *(Netherlands)*
***Radio (China)***
Radio (China)
*see* ***Wu Hsien Tien***
***Radiobiol. Biol. Mol.***
Radiobiologia si Biologia Moleculara *(Romania)*
***Radioprotection***
Radioprotection. Bulletin de la Societe Francaise de Radioprotection *(France)*
***Rad. Poljopr. Fak. Univ. Sarajevu***
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*
***Rakuno Kagaku No Kenkyu***
Rakuno Kagaku No Kenkyu (Japanese Journal of Dairy Science) *(Japan)*
***Rast. Nauki***
Rasteniev'dni Nauki *(Bulgaria)*
***Razved. Okhr. Nedr***
Razvedka i Okhrana Nedr *(U.S.S.R.)*
***RCN (Reactor Cent. Ned.) Mededel.***
RCN (Reactor Centrum Nederland) Mededeling *(Netherlands)*
***Reactor Fuel-Process. Technol.***
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*
***Rec. Trav. Bot. Neer.***
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*
***Rend. Semin. Mat. Fis. Milano***
Rendiconti del Seminario Matematico e Fisico di Milano *(Italy)*
***Rep. Fac. Eng., Yamanashi Univ.***
Reports of the Faculty of Engineering, Yamanashi University
*see* ***Yamanashi Daigaku Kogakubu Kenkyu Hokoku***
***Rep. Fac. Sci., Shizuoka Univ.***
Reports of Faculty of Science, Shizuoka University *(Japan)*
***Rep. Fire Res. Inst. Jap.***
Report of Fire Research Inst. of Japan
*see* ***Shobo Kenkyusho Hokoku***
***Rep. Hokkaido Inst. Public Health***
Report of the Hokkaido Inst. of Public Health
*see* ***Hokkaidoritsu Eisei Kenkyushoho***
***Rep. Ind. Res. Inst., Osaka Prefect.***
Reports of Industrial Research Inst., Osaka Prefecture
*see* ***Osaka Furitsu Kogyo Shoreikan Hokoku***
***Rep. Nat. Res. Inst. Police Sci.***
Reports of the National Research Inst. of Police Science
*see* ***Kagaku Keisatsu Kenkyusho Hokoku***
***Rep. Res. Inst. Ind. Safety***
Reports of the Research Inst. of Industrial Safety
*see* ***Sangyo Anzen Kenkyusho Hokoku***
***Rep. Res. Inst. Sci. Ind., Kyushu Univ.***
Reports of the Research Inst. of Science and Industry, Kyushu University
*see* ***Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku***
***Rep. Tokyo-to Lab. Med. Sci.***
Report of Tokyo-to Lab. for Medical Sciences
*see* ***Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku***
***Rep. Train. Inst. Eng. Teach., Kyoto Univ.***
Report of the Training Inst. for Engineering Teachers, Kyoto University
*see* ***Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku***
***Res. Electrotech. Lab.***
Researches of the Electrotechnical Laboratory
*see* ***Denki Shikenjo Kenkyu Hokoku***
***Res. Rep., Nagano Tech. Coll.***
Research Reports, Nagano Technical College
*see* ***Nagano Kogyo Koto Senmon Gakko Kiyo***
***Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza***
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*
***Rev. Brasil. Quim. (Sao Paulo)***
*Revista Brasileria de Quimica *(Brazil)*
***Rev. Elec.***
Revista Electricidade *(Portugal)*
***Rev. Energ. Primaire***
Revue Energie Primaire *(Belgium)*
***Rev. Fac. Cienc. Agr., Min. Educ., Univ. Nac. Cuyo (Mendoza)***
Revista de la Facultad de Ciencias Agrarias, Ministerio de Educacion, Universidad Nacional de Cuyo (Mendoza) *(Argentina)*
***Rev. Fr. Elec.***
*Revue Francaise de l'Electricite *(France)*
***Rev. Fr. Odonto-stomatol.***
Revue Francaise d'Odonto-stomatologie *(France)*
***Rev. Gen. Caout. Plast.***
Revue Generale du Caoutchouc et des Plastiques *(France)*
***Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo***
Revista do Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo *(Brazil)*
***Rev. Interamer. Radiol.***
Revista Interamericana de Radiologia *(Peru)*
***Rev. Int. Oceanogr. Med.***
*Revue Internationale d'Oceanographie Medicale *(France)*
***Rev. Invest. Agropecuar., Ser. 4***
Revista de Investigaciones Agropecuarias, Serie 4. Patologia Animal *(Argentina)*
***Rev. Laryngol., Otol., Rhinol., Suppl.***
Revue de Laryngologie, Otologie, Rhinologie, Supplement *(France)*
***Rev. Latinoamer. Microbiol. Parasitol.***
Revista Latinoamericana de Microbiologia y Parasitologia (formerly Revista Latinoamericana de Microbiologia) *(Mexico)*
***Rev. Real Acad. Cienc. Exact., Fis. Nat. Madrid***
Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid *(Spain)*
***Rev. Roum. Sci. Tech., Ser. Mecan. Appl.***
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*
***Rev. Soudure (Brussels)***
Revue de la Soudure (Brussels) *(Belgium)*
***Rev. Stomatol.***
Revue de Stomatologie *(France)*
***Rev. Zootch. Med. Vet.***
Revista de Zootehnic si Medicina Veterinara *(Romania)*
***Rheol. Acta***
Rheologica Acta *(West Germany)*
***Riv. Mineraria Sicil.***
Rivista Mineraria Siciliana *(Italy)*
***Riv. Parassitol.***
Rivista di Parassitologia *(Italy)*
***Roczn. Akad. Med. Bialymstoku***
Roczniki Akademii Medycznej im. Juliana Marchlewskiego w Bialymstoku *(Poland)*
***Rom. Med. Rev.***
Romania Medical Review *(Romania)*
***Roy. Observ. Bull.***
Royal Observatory Bulletins *(England)*
***Roy. Soc. Health J.***
Royal Society of Health Journal *(England)*
***Rudarsko-Met. Zbornik, Suppl.***

Rudarsko-Metalurski Zbornik, Supplement *(Yugoslavia)*
*For English Translation see Mining Met. Quart., Suppl.*

***Rudodobiv Met. (Sofia)***
Rudodobiv i Metalurgiya (Sofia) *(Bulgaria)*

***Ruimtevaart***
Ruimtevaart *(Netherlands)*

***RUM, Rev. Universelle Mines***
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l' Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*

***Russ. Chem. Rev. (Engl. Transl.)***
Russian Chemical Reviews (English Translation of Uspekhi Khimii) *(England)*

***S. Afr. Mech. Eng.***
South African Mechanical Engineer, The *(South Africa)*

***Sakh. Prom.***
Sakhamaya Promyshlennost *(U.S.S.R.)*

***Salt Res. Ind. (Bhavnagar, India)***
Salt Research and Industry (Bhavnagar, India) *(India)*

***Samoletostr. Tekh. Vozdush. Flota***
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*

***Sangyo Anzen Kenkyusho Hokoku***
Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*

***Sankyo Kenkyusho Nenpo***
*Sankyo Kenkyusho Nenpo (Annual Report of Sankyo Research Laboratory) *(Japan)*

***Savremena Poljopr.***
Savremena Poljoprivreda *(Yugoslavia)*

***Sb. Geol. Ved, Uzita Geofyz.***
Sbornik Geologickych Ved, Uzita Geofyzika *(Czechoslovakia)*

***Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, Suppl.***
Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove, Supplementum *(Czechoslovakia)*

***Scand. J. Clin. Lab. Invest., Suppl.***
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*

***Schweiz. Arch. Tierheilk.***
Schweizer Archiv fuer Tierheilkunde *(Switzerland)*

***Schweiz. Muenzbl.***
Schweizer Muenzblaetter *(Switzerland)*

***Sci. Avenir***
Sciences et Avenir *(France)*

***Sci. Bull. Fac. Agr., Kyushu Univ.***
Science Bulletin of the Faculty of Agriculture, Kyushu University
*see Kyushu Daigaku Nogakubu Gakugei Zasshi*

***Sciences (Paris)***
Sciences et l'Enseignement des Sciences (Paris) *(France)*

***Sci. Forum***
Science Forum *(Canada)*

***Sci. Ind. Spatiales***
Sciences et Industries Spatiales *(Switzerland)*

***Sci. News (Wash., D. C.)***
Science News (Washington, D. C.) *(U. S.)*

***Sci. Proc. Roy. Dublin Soc., Ser. A***
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

***Sci. Publ. Fuji Photo Film Co., Ltd.***
Scientific Publications of the Fuji Photo Film Co., Ltd.
*see Fuji Shashin Fuirumu Kenkyu Hokoku*

***Sci. Rep., Coll. Gen. Educ., Osaka Univ.***
Science Report, College of General Education, Osaka University *(Japan)*

***Sci. Rep. Niigata Univ., Ser. B***
Science Reports of Niigata University, Series B. Physics *(Japan)*

***Scot. J. Polit. Econ.***
Scottish Journal of Political Economy *(Scotland)*

***Scr. Met.***
Scripta Metallurgica *(U. S.)*

***Sekiyu Gakkaishi***
Sekiyu Gakkaishi (Journal of the Japan Petroleum Institute) *(Japan)*

***Seminars Hematol.***
*Seminars in Hematology *(U. S.)*

***Seminars Roentgenol.***
Seminars in Roentgenology *(U. S.)*

***Sen'I Gakkaishi***
Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*

***Ser. Haematol.***
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*

***Sheet Metal Ind.***
Sheet Metal Industries *(England)*

***Shionogi Kenkyusho Nenpo***
*Shionogi Kenkyusho Nenpo (Annual Report of Shionogi Research Laboratory) *(Japan)*

***Shipping World Shipbuilder***
Shipping World and Shipbuilder *(England)*

***Shobo Kenkyusho Hokoku***
Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*

***Shokubai***
*Shokubai (Catalyst) *(Japan)*

***Shokuhin Eiseigaku Zasshi***
*Shokuhin Eiseigaku Zasshi (Journal of the Food Hygienic Society of Japan) *(Japan)*

***Showa Densen Denran Rebyu***
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

***Showa Wire Cable Rev.***
Showa Wire and Cable Review
*see Showa Densen Denran Rebyu*

***Sichere Arb.***
Sichere Arbeit *(Austria)*

***Slaboproudy Obz.***
Slaboproudy Obzor *(Czechoslovakia)*

***S. Lumberman***
Southern Lumberman *(U. S.)*

***Soc. Petrol. Eng. J.***
Society of Petroleum Engineers Journal, The *(U. S.)*

***Soil Crop Sci. Soc. Fla., Proc.***
Soil and Crop Science Society of Florida, Proceedings *(U. S.)*

***Solid State Technol.***
Solid State Technology *(U. S.)*

***Soln. Dannye***
Solnechnyie Dannye *(U.S.S.R.)*

***Soobshch. Shemakhinskoi Astrofiz. Observ., Akad. Nauk Azerb. SSR***
*Soobshcheniya Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

***Southwest. Natur.***
Southwestern Naturalist *(U. S.)*

***Sov. Antarct. Exped. Inform. Bull.***
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*

***Sov. Med.***
Sovetskaya Meditsina *(U.S.S.R.)*

***Sov. Phys.-Semicond. (Engl. Transl.)***
Soviet Physics-Semiconductors (English Translation of Fizika i Tekhnika Poluprovodnikov) *(U. S.)*

***Space Biol. Med. (USSR) (Engl. Transl.)***
Space Biology and Medicine (USSR) (English Translation of Kosmicheskaya Biologiya i Meditsina) *(U.S.)*

***Space Life Sci.***
Space Life Sciences *(Netherlands)*

***Spectrum (Oxford)***
Spectrum (Oxford) *(England)*

***Spis. Bulg. Akad. Nauk.***
Spisanie na Bulgarskata Akademiya na Naukite *(Bulgaria)*

***SRW (Siemens-Reiniger-Werke) Nachr.***
SRW (Siemens-Reiniger-Werke) Nachricht *(West Germany)*

***Ssu Ch'uan Ta Hsueh Hsueh Pao--Tzu Jan K'o Hsueh***
Ssu Ch'uan Ta Hsueh Hsueh Pao--Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium, Universitatis Szechuanensis) *(China)*

***Stainless (Tokyo)***
Stainless, The (Tokyo)
*see Sutenresu*

***Stain Technol.***
Stain Technology *(U. S.)*

***Steel Times***
Steel Times *(England)*

***Strahlenschutz Forsch. Prax.***
Strahlenschutz in Forschung und Praxis *(West Germany)*

***Strain***
Strain *(England)*

***Stroit. Mater.***
Stroitel'nye Materialy *(U.S.S.R.)*

***Stud. Cercet. Endocrinol.***
Studii si Cercetari de Endocrinologie *(Romania)*

***Stud. Cercet. Energ. Electrotch.***
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

***Stud. Cosmic Ray***
Studies of Cosmic Ray

**see Uchusen Kenkyu**

***Sumitomo Kinzoku***
Sumitomo Kinzoku (Sumitomo Metals) *(Japan)*

***Sumitomo Metals***
Sumitomo Metals
**see Sumitomo Kinzoku**

***Surv. Mapp.***
Surveying and Mapping *(U. S.)*

***Sutenresu***
Sutenresu (The Stainless) *(Japan)*

***Svetsaren Engl.***
Svetsaren in English *(Sweden)*

***Sv. Lakartidn.***
Svenska Lakartidningen *(Sweden)*

***Sv. Naturvetensk.***
Svensk Naturvetenskap *(Sweden)*

***T'ai-wan I Hsueh Hui Tsa Chih***
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China (Taiwan))*

***Tanpakushitsu Kakusan Koso***
Tanpakushitsu Kakusan Koso (Protein, Nucleic Acid, Enzyme) *(Japan)*

***Tech. Dig. (Prague)***
Technical Digest (Prague), Statni Nakladatelstvi Technicke Literatury *(Czechoslovakia)*

***Tech. Mitt. AEG-Telefunken***
*Technische Mitteilungen AEG-Telefunken (a continuation of AEG-Mitteilungen) *(West Germany)*

***Technik (Berlin)***
Technik (Berlin), Die *(East Germany)*

***Technology (Sindri)***
Technology (Sindri). Quarterly Bulletin of the Planning and Development Div., Fertilizer Corp. of India Ltd. *(India)*

***Technol. Rep. Kyushu Univ.***
Technology Reports of the Kyushu University
**see Kyushu Daigaku Kogaku Shuho**

***Tech. Note Port Harbour Tech. Res. Inst., Min. Transp., Jap.***
Technical Note of Port and Harbour Technical Research Inst., Ministry of Transporation, Japan
**see Kowan Giken Shiryo**

***Tech. Petrole***
Techniques du Petrole *(France)*

***Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A***
Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

***Tech. Rep. Kumamoto Univ.***
Technical Reports of the Kumamoto University
**see Kumamoto Daigaku Kogakubu Kenkyu Hokoku**

***Tech. Rep. Nisshin Steel Co., Ltd.***
Technical Report of Nisshin Steel Co., Ltd.
**see Nisshin Seiko Giho**

***Tech. Sci. Aeronaut. Spatiales***
Technique et Science Aeronautiques et Spatiales *(France)*

***Tec. Ital.***
Tecnica Italiana *(Italy)*

***Tekhnol. Organ. Proizvod.***
Tekhnologiya i Organizatsiya Proizvodstva *(Ukrainian S.S.R.)*

***Tekst. Prom.***
Tekstil'naya Promyshlennost *(U.S.S.R.)*

***Teor. Prakt. Met., Sov. Nar. Khoz. Chelyabinsk. Ekon. Admin. Raiona, Nauch.-Issled. Inst. Met.***
Teoriya i Praktika Metallurgii, Sovet Narodnogo Khozyaistva Chelyabinskogo Ekonomicheskogo Administrativnogo Raiona, Nauchno-Issledovatel'skii Institut Metallurgii *(U.S.S.R.)*

***Terapia (Milan)***
Terapia (Milan) *(Italy)*

***Terapia (Turin)***
Terapia (Turin) *(Italy)*

***Therapiewoche***
Therapiewoche *(West Germany)*

***Thin Solid Films***
Thin Solid Films *(Netherlands)*

***Thoraxchir. Vask. Chir.***
Thoraxchirurgie und Vaskulaere Chirurgie (formerly Thoraxchirurgie) *(West Germany)*

***Tidskr. Dok. (Swed.)***
Tidskrift for Dokumentation *(Sweden)*

***Tien Shih Chieh***
Tien Shih Chieh (Electrical World) *(China)*

***Tijdschr. Primaire Energ.***
Tijdschrift Primaire Energie
**see Rev. Energ. Primaire**

***Timisoara Med.***
*Timisoara Medicala *(Romania)*

***Tohoku Daigaku Senko Seiren Kenkyusho Iho***
Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

***Tohoku Igaku Zasshi***
*Tohoku Igaku Zasshi (Tohoku Medical Journal) *(Japan)*

***Tohoku Med. J.***
Tohoku Medical Journal
**see Tohoku Igaku Zasshi**

***Tokyo Astron. Bull., Ser. II***
Tokyo Astronomical Bulletin, Series II *(Japan)*

***Tokyo Daigaku Jishin Kenkyusho Iho***
Tokyo Daigaku Jishin Kenkyusho Iho (Bulletin of the Earthquake Research Inst., University of Tokyo) *(Japan)*

***Tokyo Daigaku Uchu Koku Kenkyusho Hokoku***
Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

***Tokyo Igaku Zasshi***
*Tokyo Igaku Zasshi (The Tokyo Journal of Medical Sciences) *(Japan)*

***Tokyo Jikeikai Ika Daigaku Zasshi***
*Tokyo Jikeikai Ika Daigaku Zasshi (Tokyo Jikeikai Medical Journal) *(Japan)*

***Tokyo Jikeika Med. J.***
Tokyo Jikeikai Medical Journal
**see Tokyo Jikeikai Ika Daigaku Zasshi**

***Tokyo J. Med. Sci.***
Tokyo Journal of Medical Sciences, The
**see Tokyo Igaku Zasshi**

***Tokyo Joshi Ika Daigaku Zasshi***
Tokyo Joshi Ika Daigaku Zasshi (Journal of Tokyo Women's Medical College) *(Japan)*

***Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku***
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

***Tonind.-Ztg. Keram. Rundsch.***
Tonindustrie-Zeitung und Keramische Rundschau *(West Germany)*

***Trans. Amer. Ophthalmol. Soc.***
Transactions of the American Ophthalmological Society *(Canada)*

***Trans. Indian Ceram. Soc.***
Tranactions of the Indian Ceramic Society *(India)*

***Trans. Ing.***
*Transactions. Ingenioeren *(Denmark)*

***Trans. Inst. Metal Finish.***
Transactions of the Institute of Metal Finishing *(England)*

***Trans. Pac. Coast Obstet. Gynecol. Soc.***
Transactions of the Pacific Coast Obstetrical and Gynecological Society *(U. S.)*

***Transp. Stroit.***
Transportnoe Stroitel'stvo *(U.S.S.R.)*

***Trans. Soc. Instrum. Contr. Eng.***
Transactions of the Society of Instrument and Control Engineers *(Japan)*

***Trans. Soc. Pathol. Jap.***
Transactiones Societatis Pathologicae Japonicae
**see Nippon Byori Gakkai Kaishi**

***Tr. Arkt. Antarkt. Nauch.-Issled.***
Trudy Arkticheskogo i Antarkticheskogo Nauchno-Issledovatel'skogo Instituta *(U.S.S.R.)*

***Travaux***
Travaux *(France)*

***Tr. Gos. Gidrol. Inst.***
Trudy Gosudarstvennogo Gidrologicheskogo Instituta *(U.S.S.R.)*

***Tr. Gos. Issled. Elektrokeram. Inst.***
Trudy Gosudarstvennogo Issledovatel'skogo Elektrokeramicheskogo Instituta *(U.S.S.R.)*

***Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal.***
Trudy, Gosudarstvennyi Nauchno-Issledovatel'skii i Proektnyi Institut Splavov i Obrabotki Tsvetnykh Metallov *(U.S.S.R.)*

***Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial***
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

***Tr. Inst. Ekol. Rast. Zhivotn.***
Trudy Instituta Ekologii Rastenii i Zhivotnykh *(U.S.S.R.)*

***Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial***
Trudy Instituta Khimii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

***Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR***
Trudy Instituta Metallurgii i Obogashcheniya, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

***Tr. Kaz. Nauch.-Issled. Inst. Onkol. Radiol.***
Trudy Kazakhskogo Nauchno-Issledovatel'skogo Instituta Onkologii i Radiologii *(Kazakh S.S.R.)*

**Tr. Kom. Spektrosk., Akad. Nauk SSSR**
Trudy Komissii po Spektroskopii, Akademiya Nauk SSSR *(U.S.S.R.)*

**Tr. Lab. Ionoobmen. Protsessov Sorbtsii, Nauch.-Issled. Fiz.-Khim. Inst., Voronezh. Gos. Univ.**
Trudy Laboratorii Ionoobmennykh Protsessov i Sorbtsii, Nauchno-Issledovatel'skii Fiziko-Khimicheskii Institut, Voronezhskii Gosudarstvennyi Universitet *(U.S.S.R.)*

**Tr. Leningrad. Tekhnol. Inst. Tsellyul.-Bum. Prom.**
Trudy Leningradskogo Tekhnologicheskogo Instituta Tsellyulozno-Bumazhnoi Promyshlennosti *(U.S.S.R.)*

**Tr., Mosk. Aviats. Tekhnol. Inst.**
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

**Tr. Mosk. Vet. Akad.**
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

**Tr. Prikl. Bot. Genet. Selek.**
Trudy po Prikladnoi Botanike, Genetike i Selektsii *(U.S.S.R.)*

**Tr. Sib. Tekhnol. Inst.**
Trudy Sibirskogo Tekhnologicheskogo Instituta *(U.S.S.R.)*

**Tr. Sov. Antarkt. Eksped.**
Trudy Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

**Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.**
Trudy Soyuznogo Nauchno-Issledovatel'skogo Instituta Priborostroeniya *(U.S.S.R.)*

**Tr. Tashkent. Gos. Univ.**
Trudy Tashkentskogo Gosudarstvennogo Universiteta im. V. I. Lenina *(U.S.S.R.)*

**Tr. Teor. Polya**
Trudy po Teorii Polya *(U.S.S.R.)*

**TRW Space Log**
TRW Space Log *(U. S.)*

**Tumor Res.**
Tumor Research *(Japan)*

**Tungsten News**
Tungsten News *(U.S.)*

**T Z Prakt. Metallbearb.**
T Z fuer Praktische Metallbearbeitung *(West Germany)*

**Uchusen Kenkyu**
Uchusen Kenkyu (Studies of Cosmic Ray) *(Japan)*

**Uch. Zap. Kazan. Vet. Inst.**
Uchenye Zapiski Kazanskogo Veterinarnogo Instituta *(U.S.S.R.)*

**Umsch. Wiss. Tech.**
*Umschau in Wissenschaft und Technik *(West Germany)*

**Univ. Mich. Med. Cent. J.**
University of Michigan Medical Center Journal *(U. S.)*

**Upr. Yadern. Energ. Ustanovkami, Sb. Statei**
*Upravlenie Yadernymi Energeticheskimi Ustanovkami, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

**U. S. Nav. Inst., Proc.**
United States Naval Institute, Proceedings *(U. S.)*

**Va. Med. Mon.**
Virginia Medical Monthly *(U. S.)*

**Vector (Baltimore)**
Vector (Baltimore) *(U. S.)*

**Ved. Pr. Vyzk. Ustavu Vet. Lek. Brne**
Vedecke Prace Vyzkumneho Ustavu Veterinarniho Lekarstvi v Brne (superseded by Documenta Veterinaria) *(Czechoslovakia)*

**Verh. Kon. Vlaam. Acad. Wetensch., Belg., Kl. Wetensch.**
Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*

**Verpakking**
Verpakking *(Netherlands)*

**Vestn. Cesk. Spolecnosti Zool.**
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*

**Vestn. Leningrad. Univ., Ser. Biol.**
Vestnik Leningradskogo Universiteta, Seriya Biologii *(U.S.S.R.)*

**Vestn. Mosk. Univ., Ser. I, Mat., Mekh.**
Vestnik Moskovskogo Universiteta, Seriya I, Matematika, Mekhanika *(U.S.S.R.)*

**Vestn. Mosk. Univ., Ser. IV. Geol.**
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*

**Vestn. Sel'skokhoz. Nauki (Moscow)**
Vestnik Sel'skokhozyaistvennoi Nauki (Moscow) *(U.S.S.R.)*

**Vestn. Ustred. Ustavu Geol.**
Vestnik Ustredního Ustavu Geologickeho *(Czechoslovakia)*

**Vet. Med. Nauki (Sofia)**
Veterinarno Meditsinski Nauki (Sofia), Izvestiya na Akademiyata na Selskostopanskite Nauki *(Bulgaria)*

**Vierteljahrsschr. Schweiz. Sanitaetsoffiz.**
Vierteljahrsschrift fuer Schweizerische Sanitaetsoffiziere *(Switzerland)*

**Visn. L'viv. Derzh. Univ., Ser. Khim.**
Visnik L'vivs'kogo Derzhavnogo Universitetu im. Ivana Franka, Seriya Khimichna *(Urkainian S.S.R.)*

**Vodosnabzh. Sanit. Tekh.**
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*

**Vojnoekon. Pregl.**
Vojnoekonomski Pregled *(Yugoslavia)*

**Vojnosanit. Pregl.**
Vojnosanitetski Pregled *(Yugoslavia)*

**Volt, Elec. Trade Mon.**
Volt, Electrical Trade Monthly *(Japan)*

**Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.**
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*

**Waldhygiene**
Waldhygiene *(West Germany)*

**Water Res.**
Water Research (supersedes in part Air and Water Pollution) *(England)*

**Water Waste Treat.**
Water and Waste Treatment *(England)*

**Wear**
Wear *(Netherlands)*

**Weld. Eng.**
Welding Engineer *(U. S.)*

**Weld. Res. Counc. Bull.**
Welding Research Council Bulletin *(U. S.)*

**Wiad. Hutn.**
Wiadomosci Hutnicze *(Poland)*

**Wien. Z. Inn. Med. Grenzgeb.**
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*

**Wis. Med. J.**
Wisconsin Medical Journal *(U. S.)*

**Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe**
Wissenschaftliche Zeitschrift der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

**Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe**
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

**Wonjaryogwon. Yon'gu Nonmun Chip**
Wonjaryogwon. Yon'gu Nonmun Chip
*see J. Nucl. Sci. (Seoul)*

**World Meteorol. Organ. Bull.**
*World Meteorological Organization Bulletin *(Switzerland)*

**World Mining**
World Mining *(U. S.)*

**Wszechswiat**
Wszechswiat *(Poland)*

**Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao**
Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao (Wuhan University Journal, Natural Sciences) *(China)*

**Wuhan Univ. J., Natur. Sci.**
Wuhan University Journal, Natural Sciences
*see Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao*

**Wu Hsien Tien**
Wu Hsien Tien (Radio) *(China)*

**Yaderno-Geofiz. Issled., Geofiz. Sb.**
Yaderno-Geofizicheskie Issledovaniya, Geoficicheskii Sbornik *(U.S.S.R.)*

**Yadern. Priborostr., Nauch.-Tekh. Sb.**
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*

**Yakugaku Kenkyu**
Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*

**Yamanashi Daigaku Hakko Kenkyusho Kenkyu Hokoku**
*Yamanashi Daigaku Hakko Kenkyusho Kenkyu Hokoku (Bulletin of the Research Inst. of Fermentation, Yamanashi University) *(Japan)*

**Yamanashi Daigaku Kogakubu Kenkyu Hokoku**
*Yamanashi Daigaku Kogakubu Kenkyu Hokoku (Reports of the Faculty of Engineering, Yamanashi University) *(Japan)*

**Yuan Tzu Neng**
Yuan Tzu Neng (Atomic Energy) *(China)*

**Zap. Leningrad. Gorn. Inst.**
Zapiski Leningradskogo Gornogo Instituta *(U.S.S.R.)*

**Zem. Beton**
Zement und Beton *(Austria)*

**Zemlya Vselennaya**
Zemlya i Vselennaya *(U.S.S.R.)*
**Zentralbl. Neurochir.**
Zentralblatt fuer Neurochirurgie *(East Germany)*
**Z. Ernaehrungswiss., Suppl.**
Zeitschrift fuer Ernaehrungswissenschaft, Supplementa *(West Germany)*
**Zesz. Nauk. Politech. Slaska, Energ.**
Zeszyty Naukowe Politechnika Slaska, Energetyka *(Poland)*
**Zh. Org. Khim.**
*Zhurnal Organicheskoi Khimii *(U.S.S.R.)*
**Z. Immunitaetsforsch., Allergie Klin. Immunol.**
Zeitschrift fuer Immunitaetsforschung, Allergie und Klinische Immunologie *(West Germany)*
**Z. Kinderheilk.**
Zeitschrift fuer Kinderheilkunde *(West Germany)*
**Z. Math. Phys.**
Zeitschrift fuer Mathematik und Physik *(East Germany)*
**Z. Mikrosk.-Anat. Forsch.**
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*
**Zolnierz Pol.**
Zolnierz Polski *(Poland)*
**Zoologica (Seoul)**
Zoologica (Seoul) *(South Korea)*
**Zool. Zh.**
Zoologicheskii Zhurnal *(U.S.S.R.)*
**Z. Parasitenk.**
Zeitschrift fuer Parasitenkunde *(West Germany)*
**Z. Phys. Chem. B**
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*
**Z. Psychol. Physiol. Sinnesorg.**
Zeitschrift fuer Psychologie und Physiologie der Sinnesorgane *(East Germany)*
**Z. Sinnesphysiol.**
Zeitschrift fuer Sinnephysiologie *(East Germany)*
**Z. Tech. Ueberwach.**
Zeitschrift Technische Ueberwachung *(Austria)*
**Z. Urol. Nephrol.**
Zeitschrift fuer Urologie und Nephrologie *(East Germany)*
**Z. Wiss. Mikrosk.**
Zeitschrift fuer Wissenschaftliche Mikroskopie und fuer Mikroskopische Technik *(West Germany)*

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